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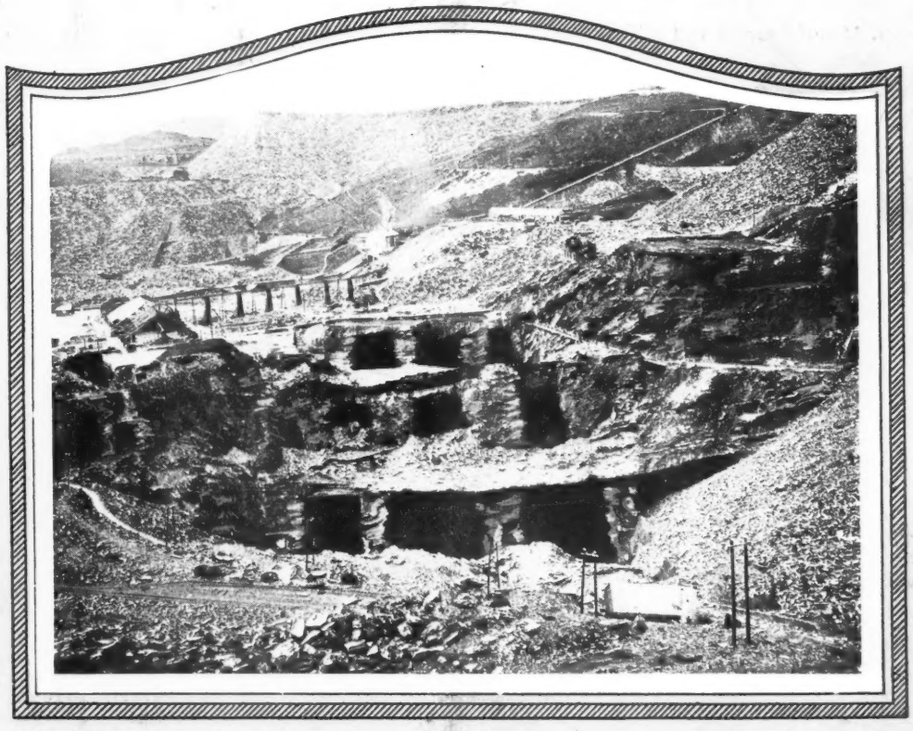

A TYPICAL SLATE QUARRY IN NORTH WALES.

[TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5]

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The Present Era of Hydro-Electric Developments

Compressed Air Essential to the Execution of the Projects—Eventually the Water Power Resources of the United States and Canada will Generate Millions of Kilowatts of Energy for Distribution Over Large Areas

By ROBERT G. SKERRETT

THE ECONOMIC strength of every nation of importance to-day depends fundamentally upon an abundance of adaptable mechanical energy. This is because industry in all of its departments is placing less of a burden upon manual effort and more of a load upon machinery of innumerable sorts. To meet the varied demands of modern civilization, production and distribution must maintain a pace hitherto unthought of; and the tide of this trend is still rising.

How, then, can this situation be met effectively and needful economy be practiced the while? The broad answer is: Find ways to produce efficiently greater blocks of motive energy—utilize to the utmost the power latent in falling waters. In short, save wherever possible the costs involved in mining, in transporting, and in burning coal wastefully in thousands and thousands of small steam plants of questionable performance.

A survey of world activities in the last five years brings to light a marked expansion of hydroelectric installations and the formulation of plans for a still wider development of water-power resources. This movement is especially conspicuous in the countries that have been most affected by the recent conflict; and well-nigh every nation in Europe is now bent upon making the most of its hydro-electric resources. Many railroads abroad are adopting electric traction where current can be obtained at a cost that will permit the abandonment of the steam locomotive; and trunk lines that have been partly electrified for some time are steadily extending their mileage of this nature.

But the significance of this new era of power generation can be grasped more fully when we are told that Australia, New Zealand, China, Japan, the Dutch East Indies, Ceylon, Formosa, South America, Iceland, Finland, etc., have taken steps to create and to enlarge water-power plants of notable capacities. "White coal," so long neglected, will henceforth supplant wherever feasible the fuel emanating from the bowels of the earth. This means that constructional tasks of pretentious proportions are to be the order of the day so that a cheaper and an especially flexible motive force may be available for endless purposes.

AMERICA is on the eve of a vast development of her water-power resources. The Federal Power Commission has under advisement at the present time more than 200 applications for permits to make greater use of our falling waters; and the aggregate of these projects involves a total of pretty nearly 15,000,000 horse-power, a decided factor in our present power production.

Most of these schemes will require extensive excavations both for the footings of the needful dams as well as for penstocks, tunnels, and other essential waterways. This work can be done quickest, cheapest, and best by means of pneumatically - operated tools and apparatus of various sorts, and it is inevitable that the construction engineers utilize these facilities.

The present article describes some phases of the work in connection with the great Queenston - Chippawa hydro-electric development, also two other proposed undertakings upon the Niagara River; and from the nature of the physical problems presented it will be plain that compressed air is capable of lending potent aid in the execution of such stupendous tasks.

Here in the United States and in neighboring Canada varied projects are under way or are soon to be started that will eventually generate millions of kilowatts of energy; and the character of the work involved in putting these undertakings through is such that physical changes must be wrought to effect the impounding of the waters or their diversion into new channels by which they may be led to Pelton wheels or whirring turbines. In these alterations of nature's face, and perhaps in burrowing through massive ledges or strata of rock, compressed air will prove indispensable as an impulse medium for drills, jackhamers, excavators, hoists, etc. This has been strikingly evidenced in the cutting of the canal in the Queenston-Chippawa development which is counted upon to give the Province of Ontario, Canada, an ultimate increase of 1,000,000 horse-power.

As will be seen by the map (p. 10241) illustrating the route of the Queenston-Chippawa Canal, the waters of the Niagara River will enter the intake at Chippawa and, after a devious path of 12¾ miles will return to the river by way of the powerhouse discharges at a point a short distance above Queenston. According to the engineers, this diversion will give an effective head of quite 305 feet at the generating station; and each cubic foot of water per second is expected to develop 30 horse-power. The present plants at Niagara Falls operate on a basis of about fifteen horse-power per cubic foot of water per second because of a lower head.

The canal section of the Queenston-Chip-

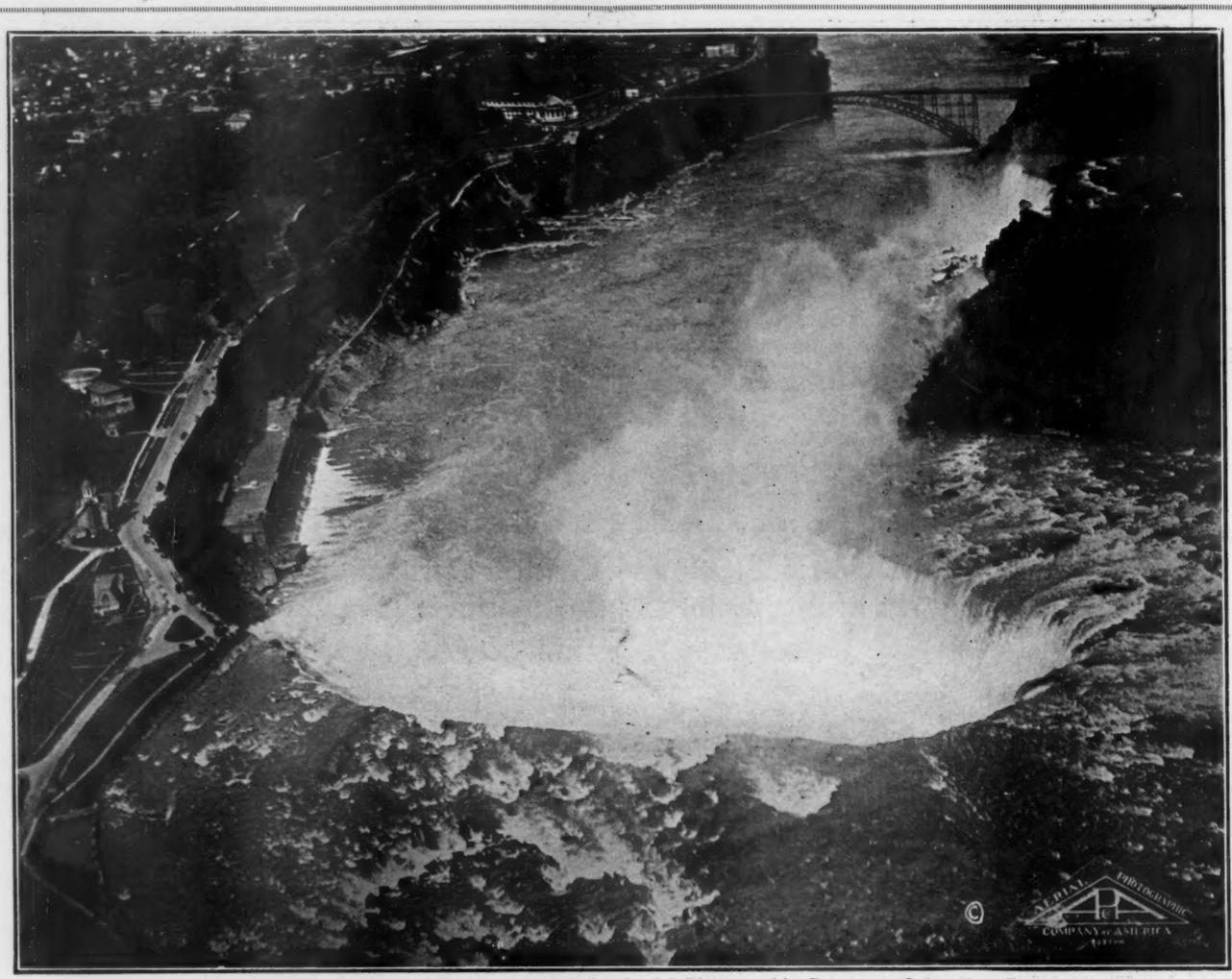


Photo taken by Lieut. F. E. Haggvist of the Aerial Photographic Company of America, Boston, Copyrighted 1921.

Aerial photograph of the Canadian Horseshoe Falls as seen from 300 feet directly over the brink with Goat Island in the middle distance.

pawa project is 8½ miles in length, and a considerable portion of this artificial waterway has been broken right through solid rock. In fact, before the task is finished, it will be necessary to clear away 4,000,000 cubic yards of rock between the Welland River and the down-stream outlet of the canal at the gate house. As may be imagined, the desire has been to provide a passage that will offer the least practicable resistance to the flowing water, and to this end especial care has been taken in cutting the canal through the rocky stretch, where the flanking walls are vertical. In order to excavate these walls in a manner that would necessitate a minimum amount of finishing, the upper ten feet of the sides are being channeled.

The channelers adopted for the work are of a very powerful model and are equipped with twin eight-inch chopping engines which strike alternately. These channelers are actuated by compressed air at a pressure of 100 pounds, and are capable of cutting to a depth of twenty feet. On the job, these apparatus are used in groups or batteries of ten on each side of the ditch, and they obtain their functional air from a main which runs along the banks of the canal from end to end. It has been found expedient to get rid of the rock between the channel cuts by drilling and shooting; and the spoils are then handled by electrically-operated shovels. This drilling is done by 3¼-inch piston air drills fitted with hollow bits of 1⅜-inch steel. Air for this purpose is carried from the compressors a maximum distance of three miles, and this motive energy leaves the plant at a pressure of 125 pounds to the square inch. The usual procedure in drilling and shooting has been to arrange the holes in a rectangular pattern, spaced about seven feet between centers and sunk to depths ranging from nine to fourteen feet. After the holes have been sprung to start cleaverage, they are reloaded with from twenty to 40 sticks of dynamite; and a total charge of 30,000 pounds of explosive has sufficed to shatter 40,000 cubic yards of rock at a single blast.

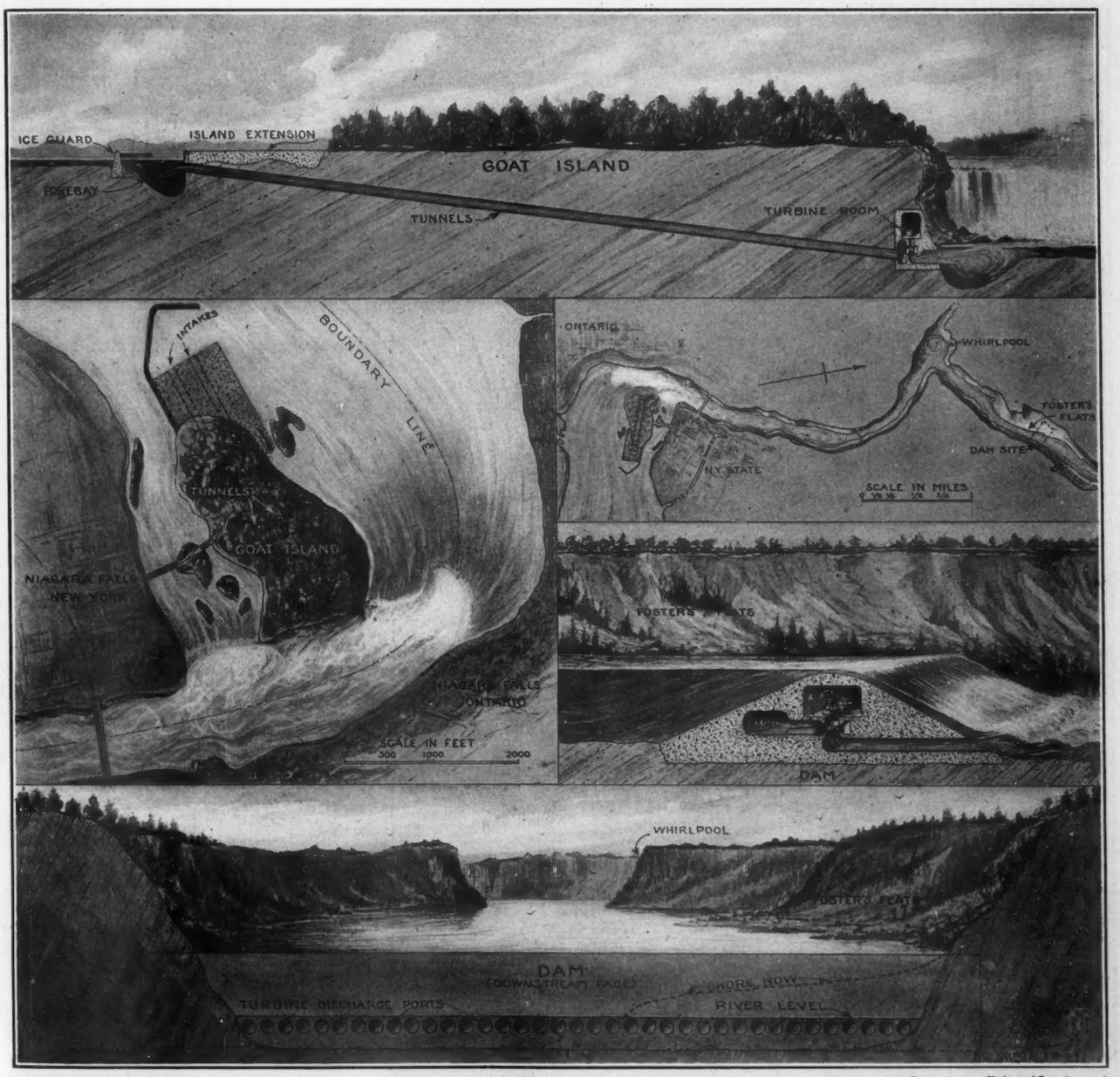
Sir Adam Beck, Chairman of the Commission.

The broken rock is cleared away by great power shovels some of which are capable of dealing with six cubic yards of material at a time and are so equipped that they can lift their loads right up from the bottom of the canal and discharge them into trains of cars at the upper level. What this means can best be understood when it is realized that the deepest of the rock cuts go down 70 feet and the maximum excavations in the earth sections are 75 feet below the normal surface. For the removal of the spoils to the points of

ultimate deposit trains of 16-yd. and 20-yd. Western dump cars are used, and a total of 200 of these pneumatically-tipped vehicles are on the job. In the course of a double-shift day of twenty hours it is practicable to load and empty from 1,400 to 1,500 cars. This would not be possible but for the facility with which the cars can be discharged through the medium of their air-operated tilting mechanisms.

Below the channeling line, the sides of the rock-hewn section of the canal will be smoothed off finally with a coating of concrete. But in order to reduce the amount of concreting needful to insure a satisfactory lining of low frictional resistance, the engineers have found it advisable to cut away to some extent the jagged surface of the blasted walls. The layer of concrete will have a minimum thickness of six inches, and it is estimated that it will involve the placing of probably quite 150,000 cubic yards of this plastic material. As a preliminary, the uneven rock is scaled, and this is being accomplished with hand air tools operated from a "scaling tower." The tower, as one of the accompanying photographs shows, is a wooden structure which nearly fills the canal prism and supports lateral platforms which can be raised or lowered as the scaling progresses. The entire framework is carried on wheels which roll upon a wide-gage track laid on the bottom of the excavation. Motive air is obtained for the scaling tools from the air mains which run parallel with the canal. Twenty-odd two-stage compressors, each having a capacity of 1,000 cubic feet of air per minute at 125 pounds pressure, are installed at various points for the purpose of generating the energy for the multiple pneumatic tools. The air is distributed through a ten-inch pipe which is fitted with four-inch vertical tees every hundred yards. As can be seen, compressed air, like electricity, as a form of secondary power, has played and is playing a conspicuous part because of its flexibility in speeding up the work on this momentous hydroelectric undertaking. Indeed, the prosecution of the great task would be hobbled but for this adaptable energizing medium.

The power-house site is situated down in the Gorge, at the Queenston terminal of the canal, and before this structure is completed it will represent the excavation of substantially 500,000 cubic yards of rock. According to the calculations of the engineers, water will flow into the forebay at the end of the canal at the rate of 15,000 second-feet and will then pass into heavy steel penstocks ranging in diameter from sixteen to fourteen feet—the

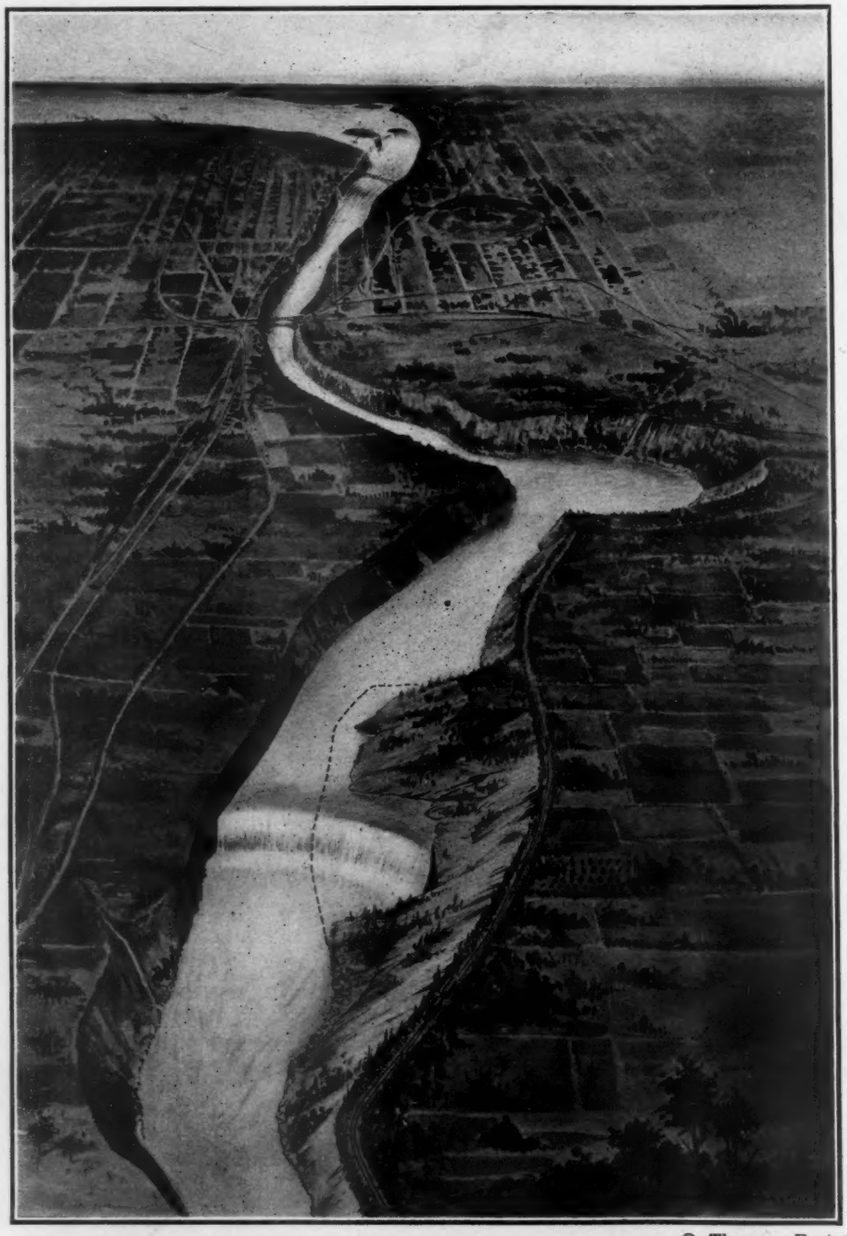


Courtesy, Scientific American.

The proposed hydro-electric developments on the Niagara River at Goat Island and Foster's Flats by which it will be possible to generate 3,500,000 horse-power.

lesser section being at the bottom of the run. All told, the present plan covers nine penstocks—eight of the size just described and the remaining one of five-foot diameter. The latter is intended to meet the service needs of the plant. Each large penstock will lead the water to a 50,000 horse-power turbine which will operate at 187½ revolutions per minute, and have a maximum guaranteed efficiency of fully 90 per cent. The runner is designed for a capacity of 61,000 horse-power, but is "gated back" to a maximum capacity of 55,000 horse-power.

The electric generators, which are directly connected to the turbines, are each of them rated at 45,000 K.V.A. and will deliver power at 12,000 volts. This voltage will be stepped up by transformers and sent out upon the transmission wires at a nominal voltage of 110,000. For the present, the main installation will include only five turbines and five big generators, but the aim is in the end to equip the plant for a total development of 500,000 horse-power. Indeed, conditions are such that the powerhouse can be added to as occasion requires; and the scheme, when carried out to its full extent, embraces the generation of 1,000,000 horse-power. The work is now being advanced so expeditiously that current will probably be dispatched from the station before the year ends; and it seems that the outlay will amount to something like $30,000,000. The Queenston-Chippawa power project was taken in hand in 1917, and was largely inspired by the war and the demand for more power for the manufacture of munitions and other military materials. To-day, the purpose is to adapt the enterprise to peacetime needs and to enable the neighboring industrial region to be just that much less dependent upon coal as a source of energy.



© Thomson-Porter.

A bird's eye-view of the Thomson-Porter scheme for the damming of the Niagara River at Foster's Flats.

The foregoing development is merely a part of a system which has been brought into being by the Ontario Hydro-Electric Power Commission in its endeavor to provide that particular province of Canada with an abundance of low-priced electric current. Last year the wires controlled by this organization distributed more than 315,000 horse-power, and two years hence the Commission expects to raise the output to 1,400,000 horse-power. To-day, 180 communities, ranging from villages to bustling cities, are the beneficiaries of the twelve units of the system which is working productive and economic wonders in the region in question.

The Ontario Hydro-Electric Power Commission was created in 1906, and its scope and authority have been amplified by various parliamentary acts since then. Broadly stated, the Commission is a governmental body which is empowered to co-operate with municipalities and districts desiring electrical energy and, incidentally, it is given the right to build and to operate transmission lines, power plants, and even railways. The object, of course, is in the end to render a service to the public at a cost that will prove a boon to all concerned.

It is rather illuminating that when the Commission asked the different private companies on the Canadian side of Niagara Falls some years ago to submit a price on 100,000 horse-power that the lowest tender was received from a plant controlled by Buffalo interests; and at that time the Commission was able to close a deal that insured it large blocks of power at rates ranging from $9.40 to $9 per horse-power per annum—the lesser figure being for greater quantities of energy. The original contract was to run until 1950. At present, the rates for lighting and power at St. Thomas, 120 miles from Niagara, are only one-half of those charged in Buffalo; and the latter city, which gets its power from a private electric company, is but eighteen miles distant from the Falls! The Commission now owns the station from which it first bought current; and inside of twelve months after acquiring that property the expense of running it was reduced more than $40,000. Efficient management has characterized the career of the Commission; and the people of the Province, both in the urban and rural sections, are turning more and more to the use of electricity. Current is delivered from Niagara Falls as far away as Windsor, just across from Detroit—a matter of 250 miles; and the citizens of Windsor pay 40 per cent. less for their electricity than their neighbors in Michigan's much larger municipality.

And now we come to a phase of this subject that touches Americans directly—i. e., a fuller utilization of the power resources of the Niagara River for our own ends. It is inevitable that those descending waters shall be made to transform their tremendous force into electric current that can be sent broadcast into our contiguous States and help us, too, to be that much less dependent upon steam-generated power. The U. S. Federal Power Commission has had filed with it numerous

applications for water rights on the Niagara River, all of which indicate our awakening to the need of action. No permission along this line, however, has latterly been given which will make any really large contribution to the current already being developed hydro-electrically on our side of the international stream.

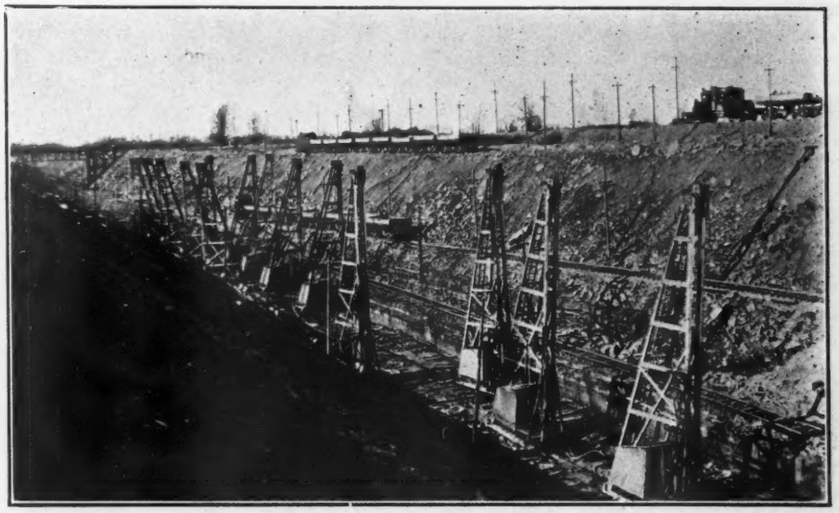
Under an existing agreement between Canada and the United States, not more than 56,000 cubic feet of water a second can be diverted above Niagara Falls for power purposes; and, by reason of certain compensatory privileges we enjoy elsewhere in connection with the boundary waters, the American allotment at the Falls is limited to 20,000 cubic feet. With reason, it has been urged that the combined international total diversion be raised to 80,000 cubic feet, and that Canada and the United States share equally—Canada to have 4,000 cubic feet more than she enjoys today, and our quota to be doubled. Should this arrangement be consummated, the friendly Governments will unquestionably grant the applications only of the concession seekers whose projects are least likely to affect the scenic grandeur of the cataracts. And this brings us to two schemes that have been well thought out by T. Kennard Thomson, C. E., of New York City, and Peter A. Porter, a resident of Niagara Falls.

In taking up these propositions there is no intention to belittle others, but the Thomson-Porter plans have elements of novelty and interest besides offering ways by which it would be feasible for us eventually to command more than 3,000,000 horse-power conjointly at the Falls and at a point a few miles below them. At the rate of only eight tons of coal per horse-power per year, based on steam plant performance, this energy from the waters of the Niagara River would represent an annual saving of 24,000,000 tons of fuel, and at but $2.50 a ton this would equal a money gain of $60,000,000 every twelvemonth—quite apart from the work and trouble involved in mining and transporting that quantity of coal.

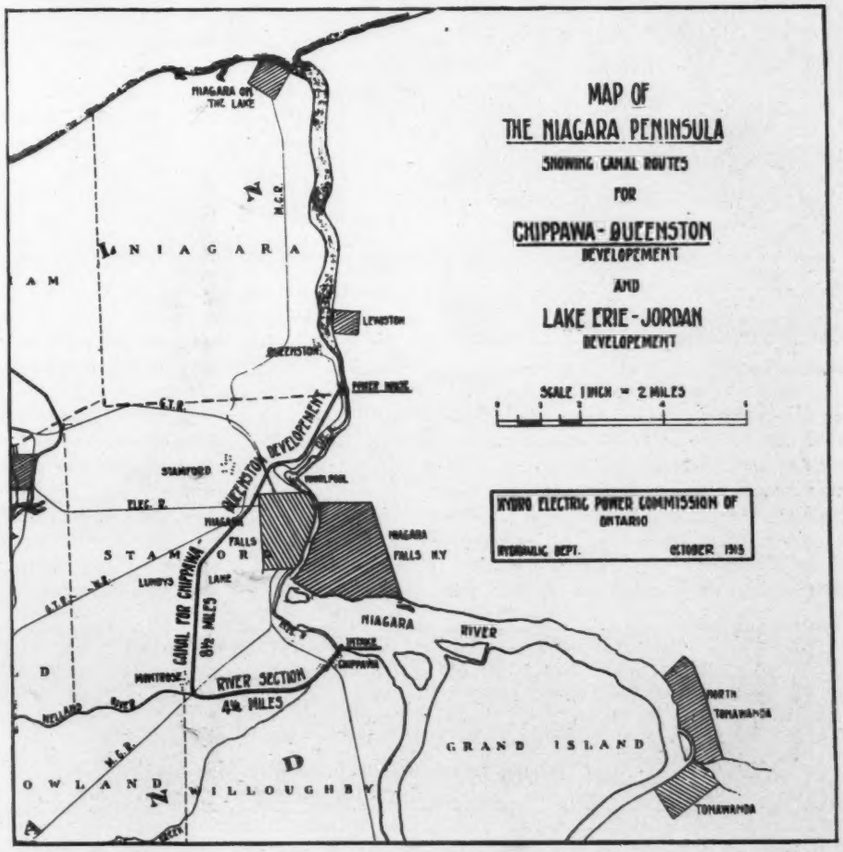
Goat Island, as those familiar with Niagara Falls know, stands squarely in the sweep of the river and divides the tumbling waters into two falls. Goat Island has survived the erosive rush of the river only because it is an integral part of the massive ledge which underlies the stream from bank to bank and forms the barrier over which the waters make their precipitous drop of 165 feet. Along its major axis, from east to west, Goat Island has a length of 2,800 feet. The Thomson-Porter plan, however, contemplates extending the island artificially 600 feet farther up stream by building a rectangular addition of cyclopean concrete upon the shallow, rocky bed of the river. The net result of this would be to increase the effective head 35 feet; and turbines, located at the base of the island on the downstream side, would thus be impelled by columns of water descending 200 feet and would be capable of generating 1,500,000 horse-power.

And right here we see how air-driven rock drills would have their work cut out for them in driving a series of slanting tunnels directly through the backbone of Goat Island. The number of these tunnels would be augmented from time to time agreeably to the demand for greater blocks of electrical energy; but at the start Messrs. Thomson and Porter recommend only two of these aqueducts, each with a finished internal diameter of twenty feet. These, with suitable turbines and generators at their lower ends, would make it possible to develop fully 200,000 horse-power.

Owing to the shallowness of the water at the intakes of the tunnels, it would be a comparatively easy matter to build cofferdams about the portals so as to hold the river at bay while the aqueducts were being driven down through the foundation of Goat Island. As the plans show, the intakes are to be shielded by a concrete breakwater, the purpose of which is to sweep aside ice, logs, and any other floating bodies that might cause trouble if they were able to reach the turbines. It is not unlikely that the whole forebay area could be temporarily enclosed to advantage, thus permitting the dry excavation of the rocky riverbed when forming the bowl of the forebay.



A battery of deep hole hollow piston drills, known as the type H-66, on the hydro-electric development.

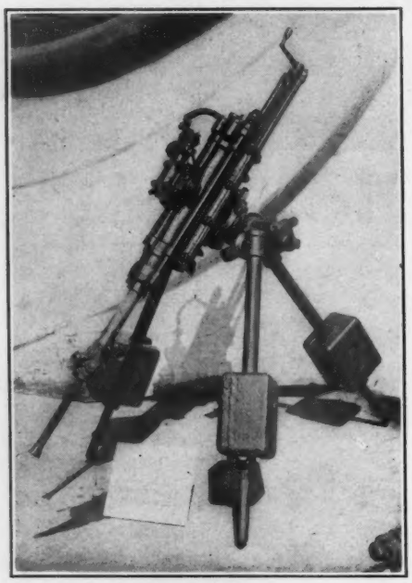


Area showing the location of the principal stations of the Chippawa-Queenston development.

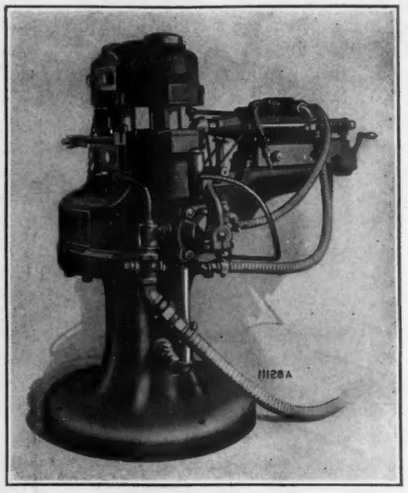
This would materially cheapen the operation and permit of more rapid execution. Doctor Thomson declares that the Goat Island scheme can be carried out and made fit for service within an interval of thirty months.

The Goat Island project should appeal especially to Americans inasmuch as the installation would be entirely on the domestic side of the Niagara. The determining question, however, is whether or not the two countries concerned can be brought into accord upon the increased diversion of water from the Falls—particularly the Horseshoe Falls, which would probably evidence more plainly the loss of any water deflected into the turbine tunnels. Otherwise, the undertaking would not materially affect the scenic beauty of the Falls.

Before Doctor Thomson conceived the Goat Island proposition he evolved his much more pretentious plan which calls for the erection of a great reinforced concrete dam squarely across the Niagara River at a point downstream and below The Rapids. In 1915, his design embodied a massive curved structure, reaching from slope to slope of the Gorge walls and rising 90 feet above the normal surface of the river. From side to side, the dam was to have a span of 1,000 feet and was to be located a short way above Queenston. After maturer consideration of his problem, Doctor Thomson discovered how he could considerably reduce the magnitude of his engineering task by placing his dam athwart the river at Foster's Flats, about four and one-half miles down from the Falls. While this calls for a barrier about 1,200 feet long, the physical situation greatly simplifies the constructional work.



Hollow piston rock drill, Little Giant type.



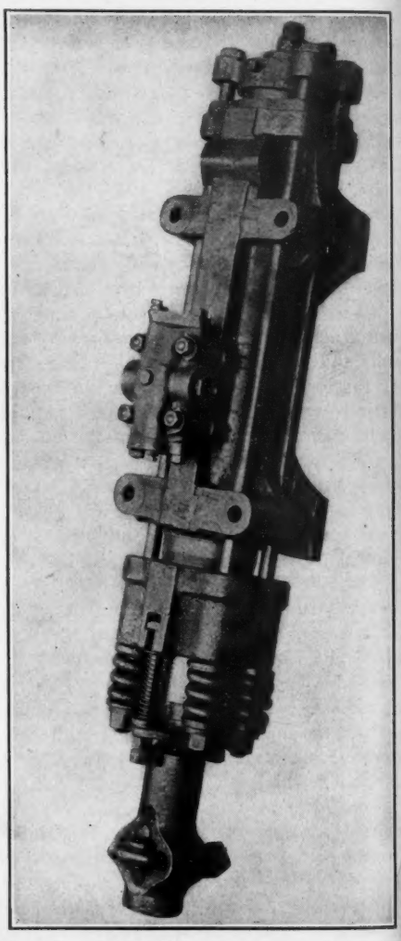
Leyner No. 5 drill steel sharpener.

From the Falls to the site chosen, the river level drops a matter of 102 feet, and the proposal is to make the dam high enough to take advantage of this difference and therefore to impound the water so that the surface will reach back unbrokenly to the very foot of the cataracts. This, of course, would involve the submergence of The Rapids but the rearrangement of the river level would create a bigger and more imposing Whirlpool. The picturesque features of the Falls, themselves, would remain unaltered.

The idea of obstructing the onrushing Niagara River may seem, off-hand, to be a staggering if not impossible undertaking, because means must be provided during building operations for the free flow of a minimum of 220,000 cubic feet of water every second. Doctor Thomson has wisely elected to profit by a topographical "accident," so to speak, of nature's making. Above and also below Foster's Flats the walls of the Gorge rise abruptly from the tideway, but at the Flats the Gorge is much wider; and on the Canadian side of the river the bank has an easier gradient while there is a goodly area of low ground immediately in touch with the stream. In short, this state of affairs will make it practicable to complete on dry land substantially half of the dam before interfering in any way with the course of the Niagara.

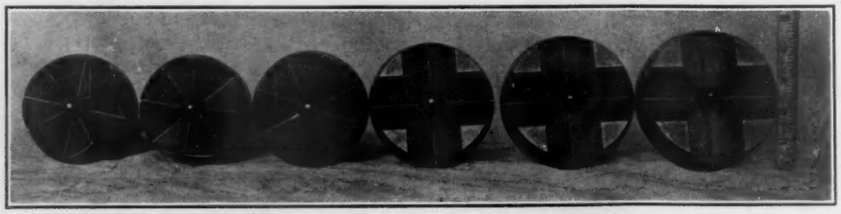
The Thomson-Porter plan shows a dam 140 feet high with a cross section 650 feet wide at the base and a broad, rounded crest. Something like 30 feet of the footing would rest in the solid rock of the riverbed. In erecting the first half of the dam, that upon Foster's Flats, the structure would be pierced transversely by a series of temporary culverts, and to these passages there would be blasted out of the stony waterbed a sufficient number of channelways upstream to accommodate the entire volume of the river's flow when it should become necessary to divert the water from its normal course.

By this arrangement, it would be quite feasible to bare the natural bed of the river so as to carry on unhampered the removal of rock and the construction of the second section of the dam. With the barrier finished, the sluiceways would be closed, and this would cause the waters to accumulate until their surface extended back to the foot of the Falls. It takes no stretch of the imagination to appreciate the impressive spectacle that would be offered by the precipitous rush of the Niagara when tumbling over this towering man-made cliff. With modern mechanical facilities and present-day materials, the proponents of this splendid project are satisfied that the work could be put through within a period of approximately three years.



Canadian Ingersoll-Rand Co.'s H-66 deep-hole hollow piston drill.

As those familiar with the Niagara River well know, there are months during the winter season when immense quantities of heavy ice are carried over the Falls and swept violently onward. Therefore, it is indispensable that



Dollies used in forging 2½ inch to 4½ inch cross bits on two inch round drill steel used with H-66 deep-hole hollow-piston drills, on the Chippawa-Queenston development.

Engineering Operations Along the Queenston-Chippawa Hydro-Electric Development

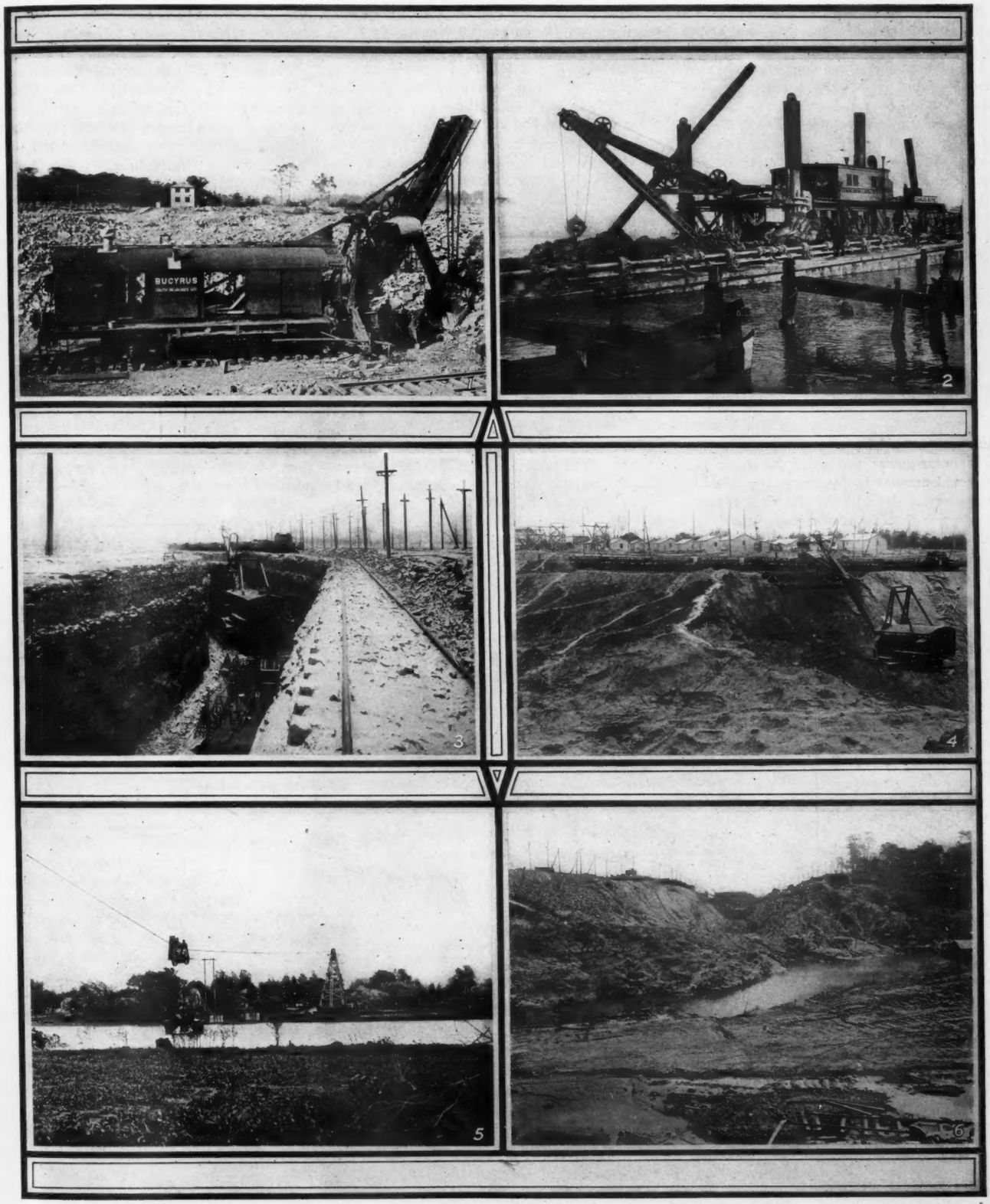


Fig. 1—A monster electrically-operated shovel, capable of lifting six tons of rock at a time, clearing away the spoils in the forebay of the Queenston-Chippawa development. Fig. 2—A powerful steam dredge at work on the Welland River section of the Queenston-Chippawa project. Fig. 3—A winter view of the rock-hewn canal showing one of the giant electrically-driven shovels loading spoils upon a train. Fig. 4—A string of Western dump cars loaded with dirt in the earth-cut section of the canal. Fig. 5—A cableway excavator on the Welland River. The control valve of the dredge is operated by compressed air. Fig. 6—Cutting the canal through the earth section which joins the Welland River. The canal is 70 feet wide at the bottom with easy sloping sides which are faced with rip-rap five feet thick.

the intercepting dam be rugged enough to withstand the impact and the cumulative pressure of floes. Even so, it is highly desirable that means be adopted to minimize these stresses and to facilitate the continued progress of the ice under the impulse of the river's currents. To this end, the dam has long slopes both upstream and down; and Doctor Thomson is confident that these comparatively easy gradients would enable the heaviest of floes to climb up and over the spillway as they are urged forward by the volume of water behind them. The slope of the descending ramp is intended to carry the ice well clear of the structure and at the same time to prevent the ice from dropping abruptly onto the river bed where it might tend to pound and to undermine the reinforced concrete mass. Finally, the modeling of the structure is calculated to obviate the formation of ice jams with their potential menace to property farther down the river.

Within the dam, as shown in one of the accompanying illustrations, there would be placed numerous turbines and electrical generators; and it is estimated that the installation could be counted upon to develop 2,000,000 horse-power. This project would entail, so it is said, an outlay of about $100,000,000. At $20 per horse-power per year, the gross income would amount to $40,000,000; and, with a commensurate demand for electrical energy, the enterprise should pay for itself in a brief while.

We should bear in mind that the tumbling waters of the Niagara River made possible our leadership in the electro-chemical industry, and called into being, because of the local abundance of cheap power, many manufacturing establishments that are of the utmost importance to our well-being in numerous respects. Similarly, it is believed that still larger blocks of electrical energy will attract a greater number of productive undertakings and, besides, make electricity available to the homes of hundreds of thousands living within transmission distance.

To-day, Niagara Falls, as a source of primary power, is sending current to Syracuse 160 miles away, and we are told that the transmission loss is less than ten per cent. at a voltage of 60,000. Over on the Canadian side of the international stream, current is being carried 250 miles, using a potential of 110,000 volts; and it is declared that by raising the electrical pressure to 220,000 volts the energy can be delivered throughout a radius of 500 miles.

Up to the present time, the United States Federal Power Commission has received over 220 applications for developmental permits; and the total of these projects represents approximately 14,600,000 horse-power. About 30 of the schemes are likely to be put through ere long, and when these hydro-electric plants are ready for service in their entirety they should be able to furnish something like 2,000,000 horse-power. They will involve an outlay of substantially $2,000,000,000.

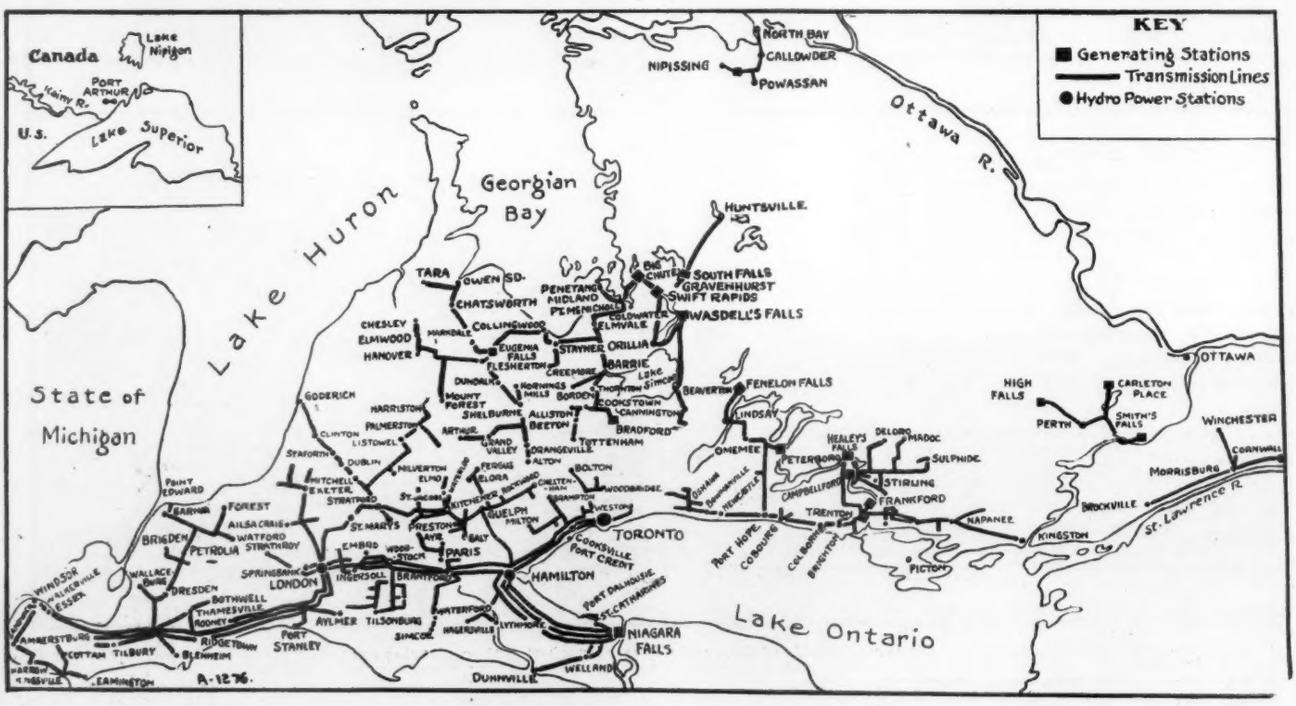
PHOTOGRAPHING STARS NEAR THE SUN'S EDGE

In the past it has been necessary to wait for an eclipse of the sun before it was possible to photograph a star in the vicinity of the sun's disk, says a writer in a recent issue of *Popular Mechanics*. The intensity of the light of the sun is so great that even the sky for a considerable distance from it is very bright, and sufficient to overwhelm completely the image of any stars that might be in the field. This can be better understood when it is stated that the brightness of the sun is equal to 120,000,000,000 first-magnitude stars.

The subject of the apparent position of the stars, as seen near the sun's limb, has recently become of great theoretical importance in connection with the gravitational theory of Professor Einstein. At the last eclipse photographs were obtained of stars near the sun; and the results appeared to indicate that Einstein's theory was borne out. However, the question is of fundamental importance to physicists and astronomers, and the effects are so minute that further data are wanted before a final conclusion is drawn; and it was naturally thought that they could not be had until the next total eclipse.

It has just been announced, however, that a French scientist has succeeded in photographing stars in the vicinity of the sun in broad daylight. This is accomplished with the aid of a screen which intercepts the direct image of the sun, and the effect of the intensely bright sky is disposed of by using suitably stained photographic plates making them sensitive to the red light, and by the employment of red filters which only allow light of certain wave lengths to pass through. It is possible, therefore, that it will not be necessary to wait for another eclipse before obtaining additional data on the Einstein theory, but that photographs can be taken at any time when the sun appears to be in the neighborhood of a star which will best suit the purpose.

A report and an estimate of the cost of the proposed Iron Canyon irrigation project have been prepared by Mr. Homer J. Gault of the U. S. Reclamation Service, Wash., D. C. The total cost of the work is estimated at over $37,000,000, the storage dam is estimated to cost about $15,000,000, and the main canal about $11,000,000. The laterals are estimated to cost about $8,000,000.



Canada's superpower zone; the distributing systems of the Ontario Hydro-Electric Power Commission.

Why Pneumatic Tamping Improves Concrete

PNEUMATIC TAMPING unquestionably adds to the wearing qualities and the permanency of concrete. These gains more than compensate for whatever expense may be involved; but only recently has it been disclosed just why the betterment should be as pronounced as it is.

Concrete in all sorts of constructional undertakings has been finding wider and wider applications in recent years, and the public at large is disposed to accept the increasing uses mainly as an evidence of the engineer's and the builder's desire to complete their work as rapidly as possible. Hence, instead of laying bricks, using cut stone, or, perhaps, depending upon a larger measure of fabricated steel, recourse is had to concrete which can be mixed quickly and poured into forms with dispatch by common labor. It is true that time saving has counted in the choice of this material, also economy in other directions, but concrete makes its claim to technical consideration upon its recognized physical merits.

Since the scientist has taken up the study of concrete and numerous laboratories in this country have subjected it to exhaustive research, facts have come to light that show that concrete is not an off-hand mixture of cement, sand, gravel, or broken stone, and water. In the past, the average concrete worker exercised his own judgment in proportioning the several ingredients or he accepted certain empirical formulae of the simple sort that prescribed mere volumetric quantities of cement, sand, etc., with an easy-going rule about "water to suit." In short, the average user aimed to make his batch fluid or plastic enough to fill forms, molds, or cavities with the least amount of effort once the stuff was dumped or poured. And then, if the concrete failed, cracked, or disappointed in any way the disposition was to blame the cement, the weather or some other factor beyond the mixer's control.

It is well established now, however, that concrete, to be rugged and to be capable of meeting exacting standards, must be compounded with considerable nicety. Assuming the cement to be of a satisfactory character—and well-nigh all of the manufacturers are careful in this respect, then the nature of the sand and the coarse aggregates, such as gravel and broken stone, cannot be accepted at their face value. The sand must be free of organic matter likely to develop tannic acid, and similarly alkaline soil should not be associated with the sand. And it is equally important that both the gravel and the stone be clean and unassociated with humus, decayed vegetable matter, etc. Simple tests have been evolved which make it feasible to detect the presence of any of these impurities which might otherwise escape the watchful eye. But even with these precautions the concrete might lack strength and wearing qualities if heed were not given to the amount of water employed in the mix.

Professor Duff A. Abrams, of the Structural Materials Research Laboratory, Lewis Institute, Chicago, has found, after making thousands of experiments, that our previous conceptions of water's relation to the ultimate strength of concrete were generally all wrong. We did not realize that relatively small quantities of water in excess of the volume needed for the purpose could seriously affect the concrete's physical properties. For example, this expert has proved that in a one-bag batch—i. e., a mixture containing one bag of cement—the addition of only a pint of water more than necessary to produce a plastic concrete will reduce the strength to the same extent as if two or three pounds of cement were omitted. Again, with a given mixture of cement and aggregates, both fine and coarse, an increase of thirteen per cent of water will cause a reduction in strength equal to that following the curtailing of the cement by 33 per cent.

Conversely, it is evident that with the proportions otherwise correct, too much water entails a waste of cement, for the latter ingredient is then unable to perform its binding function to the fullest extent. The superabundant water weakens the action of the cement, and a final result is obtained which could be secured, if desired, by using less cement in the first place and, of course, less water. To be sure, a rich cement mixture will give a higher strength than a lean one, but this is not due, as might be expected, to the mere presence of more cement. The more satisfactory outcome is owing to the fact that the concrete can then be mixed with a water-ratio which, relatively speaking, is lower in the case of the richer mixture than in the lean one.

Adverting to the work in the laboratory of the Lewis Institute, Professor Abrams says that the experiments have "shown that the water is the most important ingredient, since very small variations in water content produce more important variations in the strength and other properties of concrete than similar changes in the other ingredients." And he lays down this rule: "Use the smallest quantity of mixing water that will produce a plastic or workable concrete. The importance of any method of mixing, handling, placing, and finishing concrete which will enable the builder to

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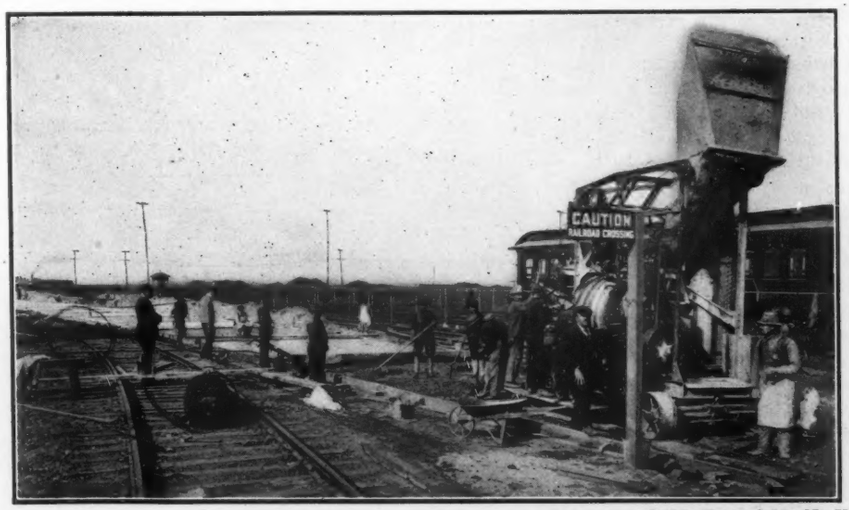
Pneumatic tamping can be used in connection with this system of cleaning surface with compressed air. View taken at Newark Bay Shipyard.



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Resurfacing Port Street, looking north from a point 25 feet east of Quartermasters' Road, at Newark Bay Shipyard.

reduce the water content of the concrete to a minimum is at once apparent." And this brings us to that point which emphasizes the benefits to be derived from thorough tamping.

As should be manifest, hand tamping has its drawbacks, both because of the time and labor involved and also by reason of the less vigorous and less uniform character of the manual operation. Mechanical tamping is distinctly superior, and the pneumatic tamper, due to certain characteristics peculiar to the air-impelled tool, is especially suited to concrete work. The pressure exerted by tamping tends to compact the freshly laid or newly-poured cement and then to occasion the forcible expulsion or squeezing out of a percentage of the mixing water. To just the extent to which the water-ratio can be thus reduced, within limits, the strength of the concrete will be augmented. The aim should be, so it seems, to bring this pressure to bear as soon as practicable. Mechanical tamping, therefore, renders it feasible to deal with drier mixtures in the first place, and obviates recourse to an undesirable measure of water to insure initial plasticity that might suffice, in itself, to induce automatic packing, as it were.

In conclusion, let it be remarked that more than $1,000,000,000 are now appropriated or pledged in this country for the construction or needful improvement of the nation's highways. The growing importance of the motor truck and the need of making the most of vehicular transportation in the distribution of raw products and finished commodities emphasize why the country's roads should be of the best. Tests made at some of our laboratories, and practical experience covering years of service, reveal that concrete roads are notably economical and, incidentally, lower hauling costs. That is to say, when the concrete road is properly built it wears well and lasts long under all service conditions and despite seasonal changes. Experiments made by the University of California disclose that on a level asphalt pavement it takes a pull of 68.5 pounds per ton of load; on a level gravel road, in good state, the pull is 78.2 pounds per ton of load; while on a level, plain-surface concrete road the pull is only 27.6 pounds per ton of load.

A two-ton motor truck, according to a series of exhaustive trial runs, will cover on a level dirt road, in fair condition, a matter of 5.78 miles on a gallon of gasoline. Over a level bituminous macadam road, the same vehicle will do 9.48 miles on a gallon of gasoline; but upon a plain surface concrete road, the truck will travel 11.78 miles on a gallon of gasoline. The promise of roads constructed of properly mixed and well-tamped concrete is one that warrants serious consideration. The capacity of concrete to withstand abrasive action, and its strength and its ability to endure radical changes of temperature are bound up in the original mixture and the amount of water then used.

Exports of Mexican oil from Tampico during the third week of July totaled 1,000,000 bbl., of which 650,000 were crude. This is about 20% of the normal rate.

INDUSTRIAL RESPIRATORS

BEFORE the war, respirators specially designed for use in industry were, practically speaking, non-existent. Experience with respirators as protection against poison gas during the war, however, has been turned to good account from the industrial point of view and Dr. Leonard Levy, at a recent meeting of the London Section of the Society of Chemical Industry, gave an account of the latest developments in this connection. Improvements have been made in the face-piece of respirators over the type used in the Army, but the canisters employed are unused small box respirator canisters of the type used in the Army, which it has been found difficult to improve upon, and, moreover, they happen to be readily obtainable in large quantities. The fillings of the canisters, however, are quite different from the Army fillings. For industrial purposes, there are now ammonia respirators, which find extensive application in cold storage plant, and for which the most satisfactory absorbent has been found to be crystalline copper sulphate. The next type gives protection against neutral vapors, such as hydrocarbon fumes in oil fields, cleaning out oil tanks, etc., and here the best results have been obtained with a filling of highly activated vegetable charcoal. A third type of filling is designed to deal with acid gases, such as hydrochloric acid, chlorine, sulphureted hydrogen, phosgene, sulphur dioxide, nitrous fumes, hydrocyanic acid, etc., and in this case it has been found that a uniform mixture of alkaline granules and charcoal has the longest life. The alkaline granules made use of by the author are slaked lime, diatomaceous earth, ferric hydroxide, and activated charcoal. Finally, there is the carbon monoxide respirator, which has presented many novel problems, because there is no known absorbent suitable for use in a respirator canister for the removal by chemical absorption of carbon monoxide from an atmosphere contaminated with this gas. An effective method, however, is by the catalytic oxidation of the carbon monoxide by the oxygen of the atmosphere, using certain special mixtures of oxide, such as finely divided manganese dioxide, copper oxide, cobalt, oxide, and silver oxide. Moreover, as carbon monoxide gives no indication of its presence, it is necessary for a detector to be embodied in the respirator, so that the wearer can be warned if the respirator has accidentally failed.

The following is reprinted from the *American Miller:*

"An airplane has been invented, so they say, for sowing grain. The seeds are expelled by air pressure with sufficient force to drive them into the ground over a strip 36 feet wide traveling at the rate of 40 miles an hour. A stream of powdered lime released at the ends of the planes mark the area covered. In six hours 640 acres can be sowed. Ho Hum!"

The Hercules Powder Co. has announced another reduction in price of 25c per hundred pounds on all Hercules high explosives, effective August 20.

COMPRESSED AIR SPEEDS UP BRICK MANUFACTURE

SEVERAL Canadian brick manufacturers using Blue or Red Medium Shale as raw material instead of the more familiar brick clay, have recently adopted air operated Jackhamers for breaking out their daily supplies of shale with remarkable results in the way of production.

This work was formerly done by hand or by tripod drills which required the services of one or two men continually, whereas, with an Ingersoll-Rand BBR-13 Jackhamer a single drill runner working one full day can keep enough broken shale ahead for an entire week's run.

The heavier BCR type Jackhamers have also proved quite satisfactory for this class of work but the smaller drill is preferable on account of its lower air consumption, lighter hitting power and faster rotation, which is an important consideration in drilling shaly ground.

The steels employed are usually shanked ⅞-in. hollow hexagon with 4 point 14° and 5° taper with 120° cutting faces. The four point bits were adopted for ease in re-sharpening and to permit the use of side blow holes in the wings when the end hole has a tendency to plug.

MELTING THE ROCKS

The melting for casting purposes of some of the primitive rocks is a somewhat novel operation which may lead to interesting developments. Dr. Ribbe, of Auvergne, has been experimenting for several years with the fusing of basalt. Basalt is a black, fine grained volcanic rock, abundant in some parts of the United States, France, and Scotland, and has crushing strength and resistance to wear superior to granite. It is employed for macadamizing roads, and as chisled blocks and tiles for bridges, sidewalks, and like purposes. It has the disadvantage of being very difficult to work, but Dr. Ribbe's discovery that it can be fused and molded at about 1,300 deg. C. seemed to overcome this difficulty, until it was found that the black vitreous product was very brittle. Further experiments have at last revealed a method of devitrifying the fused substance and restoring the original crystallization. The new material is claimed to be superior as an electric insulator, to yield building blocks and tiles of extraordinary strength and durability, and to be peculiarly adapted to withstand acids and other chemicals in the industries. Blowing air through it while melted yields a pumice-like roofing material.

The Lumen Bearing Company of Buffalo, N. Y., and Youngstown, Ohio, manufacturers of the well-known line of Machinebronze, brass and bronze castings and bearings, solders and babbitts have, owing to the increase in their activities, found it necessary to locate in Chicago a branch office that will supply and handle all business of the company west of and including Michigan with the exception of the City of Detroit, and west of a line from Toledo, to Columbus to Cincinnati; Kentucky, Tennessee and Georgia.

Slate Quarrying in North Wales

Compressed Air Now in General Use Throughout Great Slate District for Operating Drills, Chippers, Pumps, Winches and Blacksmith Hammers

By ROLAND H. BRIGGS

SLATE QUARRYING is carried on in Maine, Massachusetts, New York, Pennsylvania and Vermont, and in Canada, France, Portugal, Saxony, Belgium and Austria, but probably nowhere in the world has the slate industry grown to such large dimensions or become of such great local importance as in Merionethshire and Carnarvonshire in North Wales. For the 30-year period ending with the European War the total output of dressed slate in Britain, largely drawn from North Wales, amounted to nearly half-a-million tons per year, and while these figures dropped very much during the war owing to the great shortage of man-power, they have again increased by a considerable amount. This increase has been assisted to a large extent by the high cost of roofing tiles, caused by costly fuel.

Compressed air has been extensively brought to the assistance of the miner in the North Wales slate industry, where the work may be correctly described as mining, at any rate in Merionethshire, where the work is carried on mostly underground. The veins run at an angle of 45 degrees, and this calls for quite a different class of mining from the Carnarvonshire slate mining area, where the work is carried out in open quarries in galleries.

The underground mining of Merionethshire is of special interest. Levels are driven into the mountain at right angles to the slate, which is then worked out in chambers or openings 30 to 40 feet wide, and as much as 70 feet high. Enormous walls of slate are left between each chamber to support the mountain above. Sixty or 70 feet higher up the mountain side another level is driven, and the same veins of slate are worked at this level, and so on through the entire strata of the slate, which extends through miles of mountain. From the top of the highest floors to the bottom of the present lowest floors, the depth of the workings is over 1,400 feet.

The two slate mining areas mentioned produce two kinds of slate, both of the highest quality, one grey in color and the other a purple blue. Sixteen thousand men have been employed at one time in these Welsh slate quarries, and the total output of these two slate areas alone has exceeded 500,000 tons of dressed slate in one year.

The power developments of the North Welsh slate quarrying industry are of great interest, typifying as they do the world's progress in harnessing the various forms of power available and in the production of power equipment. For many years water power was entirely used, an extensive system of reservoirs, troughs and water-wheels being installed and supplying the power required for hoisting, hauling, pumping and similar purposes.

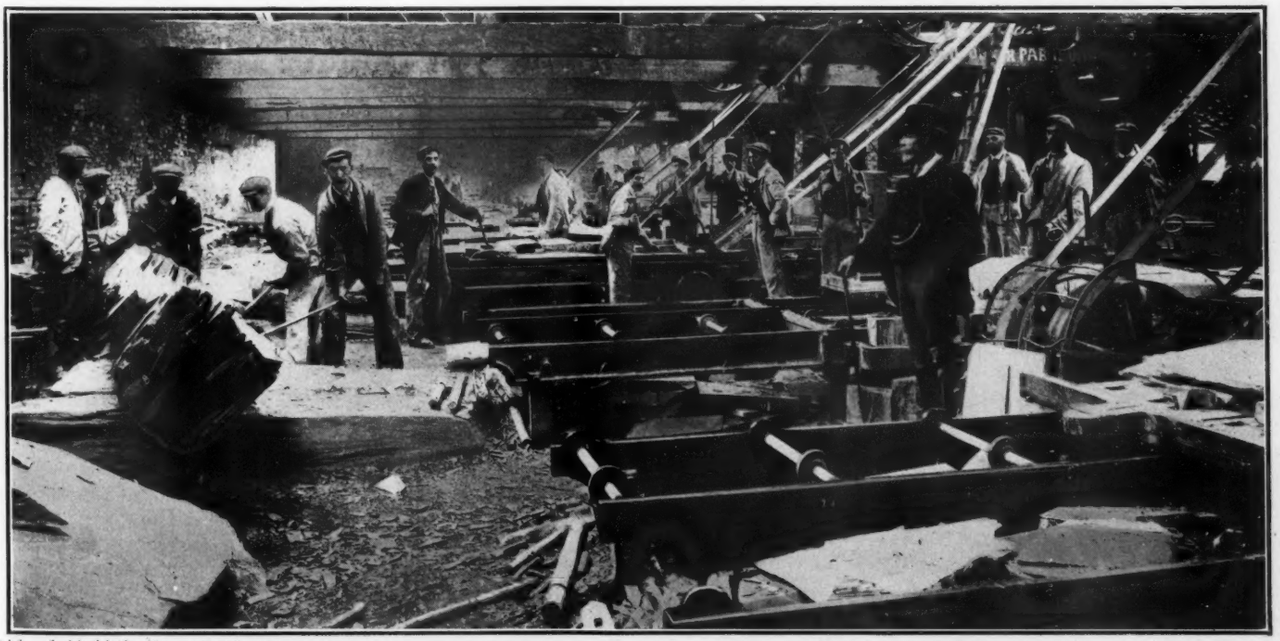
Although the district has a very heavy rainfall, however, amounting in many parts to over 100 inches per year, even the extensive catchment areas available to feed the reservoirs proved insufficient to provide the necessary water supply throughout the year, and long stoppages would periodically take place through drought in summer or through hard frost in winter, which cut off the power.

In the course of scientific progress therefore steam was introduced and this tended to the elimination of stoppages caused through failure in the water supply. Following closely on the introduction of steam, was the installation of a compressed air plant, and the great value of this form of power was made evident. Messrs. J. W. Greaves and Sons, one of the large quarry proprietors in this area, were using compressed air in their quarries by the year 1887.

A further advance was made by the introduction of electricity, which was soon shown to be of great value for many purposes, as it tended to the more rapid working of the slate rock both in the open quarries and the underground chambers, to the more efficient splitting and dressing of the slate, and to the improvement of the lighting of the underground workings, and the driving of the plant in the workshops and fitting shops, and the more economical operation of the mills, pumps, air compressors, and winding engines.

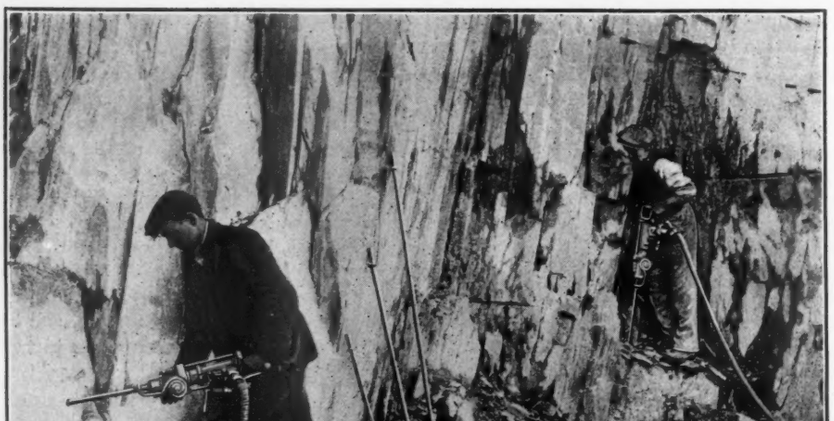
Messrs. J. W. Greaves were the first to use electricity at their Llechwedd Quarries in 1890, and they were soon followed by the Votty and Bowydd Quarry Company in 1901, and by the Dinorwic, Oakeley, Penrhyn and Penyrorsedd quarries shortly afterwards. Messrs. Greaves were also the inventors of the dressing machine, which has replaced the old-fashioned and unsatisfactory guillotine, and hand knife and traverse, which were used in earlier days.

Most of the quarries draw their power from the North Wales Power and Traction Com-

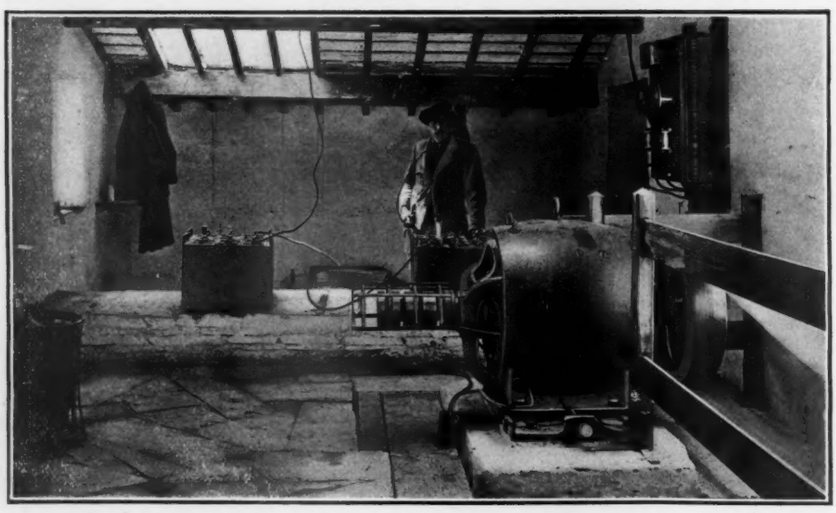


Slate mill at Votty and Bowydd's quarry

Electric battery locomotive at Greaves & Sons Quarry in the North Wales District.



Using the hand hammer type drill to advantage in a slate quarry in North Wales.



Electric battery locomotive charging sets at Greaves & Sons quarry.

pany's electric power station, but the despatch of the slates can fortunately all be carried out by gravity, over the whole run of twelve miles to Portmadoc, from which town the slates are shipped by sea. Locomotives of the Fairlie Patent double-ended type are used for hauling the empty trucks up the incline from the sea back to the mines.

From the details of the most important quarries and their equipment given below, and from the photographs with which this article is illustrated, a good idea can be obtained of the whole industry of slate mining, as carried out in North Wales. The writer has been greatly assisted in the preparation of the article, by Mr. M. I. Williams-Ellis, A. M. I. E. E., A. M. I. Mech. E., M. I. S. A. E., an engineer of very wide experience and with an exceptional knowledge of slate quarrying conditions, who has collected the data and photographs on which the article is based.

The Oakeley Slate Quarry, which has the distinction of being the largest underground slate quarry in the world, has been worked continuously for over 200 years. From 1888 to 1912 more than sixteen million tons of slate rock were mined here. The total number of floors is 26, and there are 50 miles of railroads, mostly underground. There are four miles of pump mains and twelve miles of compressed air mains, and the plant includes twelve large dressing mills, with 500 saw tables, and six hydraulic and electric pumps, capable of raising 250,000 gallons per hour.

The power is reduced in a central transformer house from 10,000 to 500 volts working pressure, and the compressor plant is well-laid out and consists of four compressor units. All of these are of the Ingersoll-Rand make, two being of the belt-driven two-stage intercooler type driven by two electric motors, and the remaining two steam driven sets. The four units are respectively of 900, 450, 280 and 170 cubic feet of free air capacity per minute, giving a total air supply of 1,800 cubic feet per minute. The compressors are interconnected and the air mains range from six inches down to one inch.

Eighty air drills are used in the quarry. The percussive type of drill is used for channeling and level driving. Channeling is one of the most important operations in rock getting at this quarry, as the rock is of a large nature and the saving of rock and explosive is considerable. It is a system which could be followed with advantage in many quarries. Special experiments were carried out some time ago with wire saws at these quarries, but these were not successful as they proved unsuitable for slate rock.

Tests were carried out in 1919 to ascertain the air consumption and drilling speed of the hammer drills used. The average drilling speed with the hammer drills on test was 6.65 inches per minute and the air consumption was 52 cubic feet of air at a pressure of 52 pounds per square inch. The average air consumption for the percussive drills was 180 cubic feet per minute. In addition to rock drills, a number of other types of compressed air plant are used in these quarries, including an air chipper,

two small air pumps, four air winches, and an air power hammer for smith's work.

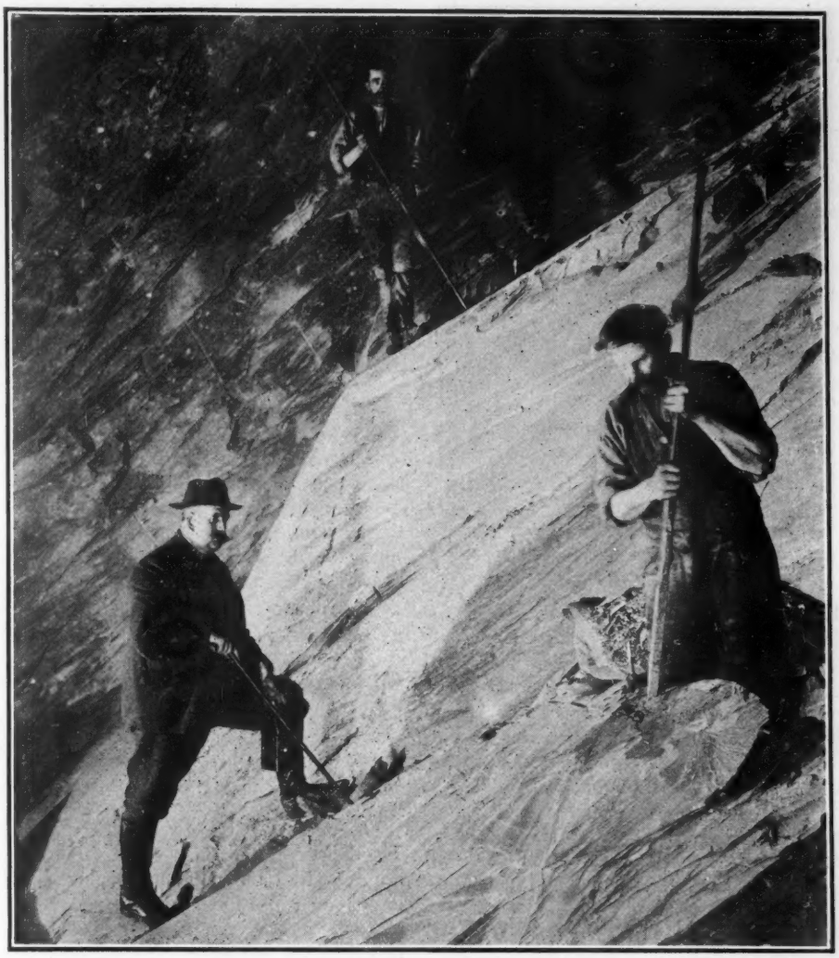
The quarries of Messrs. J. W. Greaves and Sons are the second largest in the British Isles, and are fitted with the most modern and self-contained equipment. An independent hydro-electric generating plant has been installed, supplying direct current to the machinery at 500 volts. The mills, pumps, winders, hoists and air compressors are all driven electrically, and the batteries of the electric locomotives are charged from this station. This slate quarry was the first to adopt battery locomotives, thus eliminating the use of ponies and horses. These battery locomotives are particularly suitable for the low levels and for working out the material on to the rubbish tips.

There are four compressed air units in this quarry. Their combined output is 750 cubic feet of free air per minute. Three are installed on the surface level and one underground, but all are interconnected and arranged to drop into load as required. There are four and one-half miles of air mains, and 38 air drills are in use, Jackhamer drills being used for the hard chert and rock.

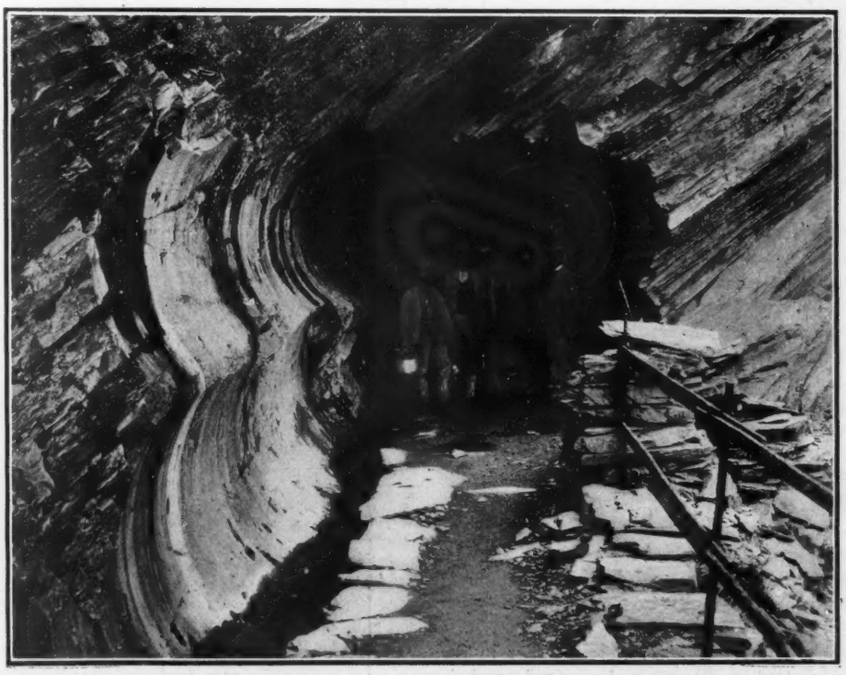
The most complete tests are being carried out at these quarries with regard to the use of compressed air for many purposes in addition to the actual drilling of the rock. Chippers are being tried for stripping rock between the channel holes and similar work, a variety of machines including the pneumatic tie-tamper being under test for this work. Tests are being carried out with regard to the riveting of wagons by pneumatic riveters, and other compressed air apparatus is being investigated for use in the quarry. Quick release hose couplings are being installed to expedite hose handling.

A hydraulic drilling plant is also at work in this quarry, its particular application being for channeling, and the pressure under which it is worked is 750 pounds. There are 25 miles of underground levels, and sixteen floors, the depth between the floors being from 40 to 60 feet. The section of this quarry shown is a typical example of an underground slate mine, and the yield obtained is about one ton of the finished product for every sixteen tons of rubbish. The quantity of rubbish dealt with is from 90,000 to 120,000 tons, the slates being now made from the Old Vein and New Vein, although the Back Vein was also worked in the past.

The Votty and Bowydd Quarries are worked on similar general lines to the other Festiniog Quarries, and the rubbish dealt with in pre-war days was about 120,000 tons per annum. The quarry was opened in 1840. It is equipped with two motor-driven air compressors, the larger one having a capacity of 400 cubic feet per minute and the smaller one 100 cubic feet. The air mains range from three inches to one inch, with a total length of over two miles. There are 21 air drills at work. The quarry has two petrol locomotives in operation, which give satisfactory results for an economical fuel consumption. The quarry is completely electrified and has a booster and battery to take up the peak loads when winding.



Underground chamber at Maenofferen Quarry.



Level at Maenofferen Quarry.

Men returning home on trolleys from Ogrigddu quarry.

The Maenofferen Quarry was opened in the year 1860 and the lowest level is over 1,500 feet from the top of the incline by means of which it is reached from the surface. In a horizontal direction the workings underground extend for a distance of a mile. From the incline sunk in the slate vein and following its dip, levels are driven horizontally, and along these some hundreds of chambers have been opened up. The chambers in the Festiniog slate quarries are the largest underground openings that have ever been made in mining practice.

The compressed air plant at this quarry consists of three electrically driven air compressors, the whole quarry being fully electrified, part of the supply being generated in their own hydro-electric station. There is a battery and booster to take up the peak loads. The air mains are two and one-half miles in length and range from three and one-half inches to one inch, and there are 30 air drills in operation. Petrol locomotives have replaced steam locomotives in these quarries.

The Park and Croesor quarries near Festiniog are underground quarries. The Park quarry is worked from the bottom instead of from the top, the galleries being worked in ascending order, so that the rubbish is left behind to support the roof and walls. Compressed air was installed in this quarry in 1881, and a number of air drills are used, and also air hoists and other apparatus. Hydraulic channeling is also largely adopted in this particular case, and the hydro-electric equipment of the quarry is of unusual interest.

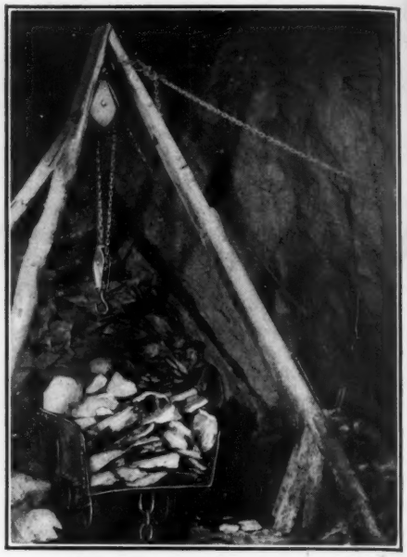
It is stated that when this plant was installed the head of water utilized was the highest of any in the British Isles, that the turbines were of special and exceedingly efficient type, that it was the first application of the three phase electric system for slate mining, that it involved the use for the first time in Britain of the multi-stage electrically-driven centrifugal pumps to slate mine drainage.

The Manod Quarry has three floors in the open and three floors underground, and is equipped with one compressor of 250 cubic feet capacity and fourteen Jackhamers of the B.B.R. type. A two-inch air main is used, which is about 2,000 yards in length, and a large suction gas engine plant, provides the power required and electricity for lighting purposes.

The Craigddu Quarry is for the most part worked as an open quarry, but a small section of the workings is underground. The compressed air plant consists of a 400 cubic foot compressor driven by a 110 b.h.p. suction gas engine. The three-inch air main is about 1,300 yards long, and about eight air drills are used. Water power is used to drive some of the plant. One of the illustrations shows the novel transport arrangements by which the workmen from this quarry return home from work. Each has a home-made three-wheel trolley, suitably braked, and rides down the inclines on the two inner rails of the double track to avoid catching the rollers.

The Penrhyn Quarry, the largest open slate quarry in the world, and worked for over 200 years, is situated at Bethesda in Carnarvonshire, and has employed as many as 3,000 men at one time. Owing to the energetic policy of the general manager, Mr. Hobson, the Chairman of the North Wales Slate Quarry Association, modern equipment has been installed in this remarkable quarry, which has its own seven-mile narrow gauge railway to its own port, where the slate is shipped on its own fleet of sea-going steamers.

The tiers of galleries rise 900 feet in height. The blocks and rubbish from these galleries are raised to the mill and tipping floors by means of five Blondin ropeways, two aerial ropeway inclines, eight water balances, and two inclined haulages. The Blondin spans across the quarry are over 1,000 feet, and the length of the quarry pit over three-quarters of a mile. The quarry is entirely electrified except for the eighteen steam haulage locomotives, the electric power supply being brought on two high tension lines at 30,000 and 10,000 volts respectively, the working pressure being reduced in the transformer houses to 500 volts. The maximum power consumption so far reached is 1,000,000 B.T.U. per annum.



In an underground chamber.

Compressed air plant was introduced in 1912 by the installation of two compressors, driven by 50 and 150 h.p. motors, and having a combined capacity of 1,260 cubic feet. The eight miles of air mains range from five inches to 1¼ inches, and the drills used number 27, almost all these being of the Ingersoll-Rand Jackhamer type. Compressed air in this quarry as in all other slate quarries has greatly reduced the manual labor of the rockmen, and improved their wage-earning capacity. The hydraulically operated drainage pumps in this quarry not only pump out the drainage water

Mechanical equipment for conveying slate blocks in North Wales Quarry.

but also their own exhaust water and the water from the water balances.

The Dinorwic Slate Quarries are the last to be dealt with. They are the second largest and have also employed at a time 3,000 men. The quarry consists of a series of galleries or flights of terraces, cut one above the other into the face of the Elidir Mountain, and receding like a giant's staircase from the floor of the quarry to the top of the mountain. From the lowest gallery to the topmost the height is 1,800 feet, and the height of each gallery is 75 feet.

An elaborate system of narrow gage (22½ inches) tramways, with a total length of 60 miles, carries the heavy slate blocks to the sheds to be split and trimmed into roofing slates, and is also used for the removal of the rubble and debris, which is dumped into the waters of Lake Padarn. The finished slate is carried down to the coast on seven miles of private standard gage railway to the company's own steamers at Port Dinorwic.

A complete new compressed air system has been recently installed at this great quarry, consisting of five compressor units, of 4,400 cubic feet total capacity. All the compressors are electric motor driven, and the compressed air is carried in six-inch and three-inch air mains, having a total length of about three miles. This air drives the 40 drills, and is also used for pumping and other auxiliary purposes. This is the story of the slate quarries of North Wales, an industry with a great past, and now that compressed air has been universally installed, one which should also have a great future.

COOLING SYSTEM FOR USE IN THE SUBWAY

By JOHN E, STARR

SOME years ago the subject of ventilating and cooling the New York subways was prominent in the minds of the Interborough company, as well as the then Board of Rapid Transit of the City of New York, and the public that utilized the subway. All of the power that was delivered to the motors operating the trains was changed into heat that raised the temperature of the subway to a disagreeable degree. Especially at the Brooklyn Bridge station was the degree of heat unbearable in the summer even at that time, while of course it would have been increased with the increasing traffic. Due to the fact that the subway was surrounded by a layer of waterproofing, the heat could only get to the ground slowly and the ground would only slowly dissipate it. So great was the volume of heat delivered at the Brooklyn Bridge station, where all through trains concentrated, that the temperature in the station often rose to 110 and 115, much to the discomfort of passengers.

The then Board of Rapid Transit employed the writer to design a plant that would relieve this condition, with the result that a final apparatus was installed that has been at work every season since. If the operation of this apparatus was stopped in warm weather the conditions would be simply intolerable.

Heat Removed by Water

The heat was finally removed by water. Two wells were sunk, each yielding on test 200 gallons per minute of 60 degree water. Only 200 gallons in all were finally employed, for it was found if 400 gallons were pumped, the head of the water at adjoining buildings on Park Row would be pulled below the head of the piles on which the buildings were built and trouble would result. This water was delivered by two centrifugal pumps (electrically operated by the same current that ran the trains) to two coils of pipe placed in two air coolers, one on each side of the station on the unused side platforms. There are about 7,000 square feet of 1-inch pipe in each, or 14,000 square feet in all. This pipe was placed on staggered close centres and then enclosed in a galvanized iron box or casing.

Fans Also Used

A fan was used at each of these casings having a capacity each of about 75,000 cubic feet of air. These fans draw the air from the body of the station and deliver it over the pipe surface, so cooling it and passing the heat into the water.

The water is then led by pipes to a small reservoir on the north platform whence it runs to the sewer.

The air, after first being driven by the fans over the cooling pipes, is led by large galvanized iron ducts to branch ducts that run the full length of the island platforms and is showered downward towards the platforms through openings placed about every ten feet, giving both the effect of the cooled air combined with the fan effect of rapid motion of air.

The general temperature of the station is reduced from fifteen to twenty degrees and rendered tolerable.

About 200 gallons, or 1684 pounds, of water are raised from 68 degrees to 79 degrees, or about 24,000 b.t.u. is taken from the subway station each minute. This is equal to 122 tons of refrigerating effect per day, at a cost only of pumping the water and operating the fans.

For a while it was planned to erect a similar cooling plant in each station from the Battery to 96th Street by piping water that could be obtained from the underflow at or near the vicinity of the Manhattan Bridge towers. But in the meantime, B. L. Turner, engineer of the Rapid Transit Commission, had completed his plan of ventilating chambers between each station. This relieved the tunnel of a great amount of fine iron dust that resulted from the friction of the break beams (estimated at a ton a mile per month) and also drove out some hot air and admitted some of the cooler surface air, and so relieved conditions as to stop the "kicking" of the public. But the Brooklyn Bridge station near the surface exposed such a large area of thin surface to the sun's rays that refrigeration is yet necessary, and the system has been in fifteen years' continuous summer use.

Cooling Plant Noticed by Few

Only a few of the public who use the subway have noticed the plant, observed the fans running on either side delivering air to be cooled or the overhead system of distributing ducts. The "regulars," however, that use this station, while they may not know where the cool air comes from, habitually are found grouped under the cool moving air that pours out of the openings at intervals along the platforms, and the guards on the locals, as they stop for a while at this station, step out from the car onto the platform to enjoy a moment's whiff of cool moving air.

Records of Temperatures

The temperature of the outside air does not always give a correct idea of the benefit of the system, as the temperature of the station when the system is not in use was often much higher than the outside air. For example, records show that on July 19, 1905, when the outside air was 84.1 degrees, the temperature of the station air was 91.1 degrees, or seven degrees higher. Other records show that when the outside air was 97 or 98 degrees the station air would run 110 degrees and upwards when the system was not running. The cooling system kept the air down to 80.9 degrees at all times, which means that it averages from eleven to twenty degrees below what it would be otherwise. This was done with 200 gallons per minute less water than was calculated. Had the full amount of water been realized, the temperature would have been six or seven degrees lower, but a temperature of from eleven to twenty degrees below what it would have been otherwise was considered a very satisfactory result.

The test record of this system shows some interesting figures on the rate of transfer in b.t.u. per square foot per hour in transferring heat from a current of air to moving water through pipes, a very vexing subject on account of the many variables in conditions.

Record of Test

Inlet Temperature of water.....	61.1	Fahr.
Outlet Temperature of water....	76.78	Fahr.
Range of water.....	15.68	deg.
Air Inlet	84.02	Fahr.
Air Outlet	75.25	Fahr.
Air after diffusion on platform..	82.35	Fahr.
True mean difference calculated by Hansbrand method	10.24	deg.
Pounds of water per minute....	1683.8	lbs.
B.t.u. per minute.....	26402	B.t.u.
B.t.u. per hour.....	1584120	B.t.u.
Surface	14200	sq. ft.
Transfer per hour per square foot per degree of difference.....	10.8	
Tons per day in terms of ice melting	132	tons

Other tests showed a rate of transfer of from 9.4 to 11.3 b.t.u. and a tonnage from 112 to 136.

The humidity of air on platform ranged from 64 per cent to 68 per cent and the heat balance, considering condensation, figured nearly correct.

It was suggested by the writer that an opening from the street to the suction of the fans might be made to take advantage of this condition whenever it occurred, but in view of the fact that the present method allowed a reasonable temperature at all time this requirement was not thought necessary.

The entire plant was put in by the Starr Engineering Company from designs by John E. Starr, loyally backed by Geo. S. Rice, chief, and B. L. Turner, assistant engineer of the Rapid Transit Commission.

The Liberty Tunnels

Two Tubes in Pittsburgh District Nearly Completed for Use of Street Railway, Vehicular Traffic and Pedestrians in Order to Relieve Present Congested Conditions

By D. E. DUNN

WHERE THE Monongahela and Allegheny Rivers meet to form the Ohio is Pittsburgh. The steady influx of population brought there by its ever increasing industrial and commercial importance soon overflowed the banks of the bounding rivers. It was but a repetition of the old story. Engineers responded with all the means at their command to the insistent cry for accessible residential locations. Numerous bridges were constructed over each of the rivers. To the north, the flourishing town of Alleghany sprang up. This has since been taken in as part of Pittsburgh proper. The expansion was not nearly so complete to the south because of the ridge called the South Hills, just on the other side of the Monongahela. This was a serious obstacle as it extends parallel with the river, varying from 300 to 500 feet in height and about three-quarters of a mile to a mile in width. Even this, however, could not withstand the force of the expanding humanity. A number of inclined railways were constructed at a great cost. These are equally expensive and unsatisfactory to operate because of their small daily capacity.

Several years ago Booth and Flinn, Ltd., one of the largest contracting companies in America, drove a street railway tunnel through this ridge. This tunnel is 22 feet in diameter by fifteen feet high, and about 4,000 feet long. Its construction was an excellent piece of engineering. It was a great boon to the West Liberty section which was thus connected with Pittsburgh. Soon, however, there was need for an additional tunnel. The contract for this new one, the Liberty Tunnel, was also awarded to Booth & Flinn, Ltd.

The Liberty Tunnel will consist of two parallel North-South tubes 59 feet from center to center through the South Hills. It will form another connecting link between Pittsburgh and West Liberty. Each of these tubes will be 5,690 feet in length and 26 feet in width by 19 feet 9 inches in height when finished. Each tube will be open to one way traffic and in each there will be a single track for the street railway, a sidewalk for pedestrians and sufficient room for two lines of vehicular traffic.

To give another view of the magnitude of the undertaking the following facts are given. The cost of the completed tunnel will be approximately $4,700,000. In excess of 1,500 tons of broken rock and dirt are now taken from the tubes each day. The total amount which will have been taken out when the tunnel has been finished will be approximately 500,000 tons.

The construction is now under full swing and has developed a speed of tunnel driving heretofore unknown. It is expected that within eighteen months, the twin tubes will be in use. From the south, Booth and Flinn have bored 2,000 feet in each tunnel and have already begun driving through the hills from the north. With crews of men now working at both ends of both tubes very rapid progress is expected. Lately the tubes have been advanced at the rate of ten feet per day and, although this pace is truly remarkable because of the difficulties of the work, Mr. R. F. Lee, the resident superintendent, states that they hope to increase their speed to fifteen feet per day advance.

The overburden consists of a top soil under which lies a highly laminated shale—almost a slate. Below this latter is a very seamy siliceous limestone. This type of ground is very difficult to tunnel. The drill steel tends to follow the numerous fissures and often causes misalignment, labored rotation and retarded

Showing work being done at the starting of the north end of the Liberty Tunnels, Pittsburgh, Pa.

Exterior and Interiors of Liberty Tunnels Showing Types of Machinery and Installation Views

Fig. 1—Marion shovels operated by compressed air in the interior of one of the portals at Liberty Tunnels, Pittsburgh, Pa. Fig. 2—Exterior of two portals at the south end of the tunnels. Fig. 3—One of four 22 and 13x16 XB-2 compressors being used at the south end. Fig. 4—Compressor plant showing three of the large belt-driven machines. Fig. 5—Two south portals of the Liberty Tunnels. Fig. 6—Leyner No. 50 drill steel sharpener installed in the blacksmith shop at the south end.

drilling speed. Instead of attempting to use heavy hitting mounted drifting machines, Booth & Flinn do their drilling with BCR-430 "Jackhamers." Six point Rose bits formed and sharpened in a Leyner No. 50 Drill Steel Sharpener are used on the 7/8-inch hollow hexagon drill steel. This combination is excellent for the rock formation encountered.

The top heading and short bench method of tunneling is used. The breast is drilled to break ten feet. The longest holes needed for this are the fourteen foot cut holes. No standard drilling round is used because the rock structure is so variable. However, full advantage is taken of every little irregularity. Forty-four holes usually constitute a round.

The drilling and blasting are done on the night shift with the exception of a few plug holes for trimming. The shots are all fired simultaneously by electricity. The rock is shoveled on the day shift by a Marion "40" steam shovel operated by compressed air. The interior haulage is accomplished by Vulcan and Climax electric mine type locomotives and steel dump cars. The haulage from the portals to the dump is handled by small traction locomotives. The water which seeps into the tubes is pumped out by Cameron "GSS" direct acting pumps operated by compressed air. These pumps are slung under the power shovels behind the rear axle.

Because of the unstable condition of the rock the top heading cannot be advanced much over ten feet ahead of the short bench. "Timber" must be in place right up to the working face because the ground will slake making it too dangerous for the men to work except under protective lagging. The "timber" is in reality arched steel beams which are delivered in segments ready to be bolted together. As soon as the roof of the heading is trimmed these beams are hoisted into place by a "Little Tugger" hoist which is bolted on the right side of the power shovel. Previous to the use of the "Little Tugger," placing these beams was awkward and dangerous, now the task is simple. The beams are assembled into an arch which rests on a rock ledge about ten feet from the floor. Immediately these are lagged with two-inch planks to protect the workmen.

Interior of one of the two portals of the Liberty Tunnels.

The tunnels are being lined throughout with a two-foot thickness of concrete which is reinforced by the steel beams mentioned above in addition to one inch twisted steel rods. A very efficient and efficacious method for placing the concrete is used. It is brought already mixed into the tunnel in a steel dump car. This car is pushed up a movable inclined trestle and the mix is dumped into a hopper. From this the concrete is blown by compressed air through a six-inch pipe in place behind a traveling Blaw collapsible steel form. Thus the entire distance of about 25 feet is concreted in one operation.

The compressed air for this work is furnished by a battery of four Ingersoll-Rand belt driven compressors and one "PRE-2" direct connected electric compressor.

Since construction of the tunnel was begun, there has been a force of 200 men, working each day.

Mr. M. L. Quinn of New York is the general superintendent of the project. His aids are John B. Sweeney, chief engineer; R. F. Lee, resident superintendent; J. C. Scott, field engineer; Geo. B. Mitchell, Ass't Res. Supt.; James Larkin, Field Cost Acc't; A. D. Nield, County Representative.

BCR-430 Jackhamers being used to drive the tunnels. There are 24 Jackhamers being used in the construction of the two portals in the south end.

Some 36 in. cast iron water mains had to be taken up in Wandsworth (England) recently, and it was decided to melt out the lead caulking from the joints by means of the oxy-acetylene blow-pipe. A long flame was used, and the joint followed round from the top for about two-thirds of its circumference, when the lengths of pipe could be separated. About 50 lb. of lead was recovered from each joint, and each operation occupied, according to *Industrial Gases*, about 45 min.

Alunite Deposits in the United States

A Little Known But Wonderfully Valuable Mineral of Great Importance in the Nation's Industries

By RICHARD HOADLEY TINGLEY

ASK ALMOST any layman to tell you the nature of potash or its products and he will have some more or less accurate information to impart; or about aluminum or sulphuric acid—again, your man will have some kind of inadequate information on the subject.

Alunite, as a basis of potash, aluminum and sulphuric acid is comparatively little known. It is too new a discovery yet to have made much of an impression on the market and the man-on-the-street knows not of it.

Ten thousand feet up in the Tushar Mountains, in Piute County, Utah, near Marysvale, about 200 miles south of Salt Lake City, miners are working in shafts and tunnels with rock drills, air compressors and dynamite, blasting out a hard, pinkish tinted "spar"—alunite. About a dozen years ago a group of Philadelphia capitalists were operating in this mountain range for gold. They found plenty of the yellow metal, but they found a great preponderance of "pink spar" deposit and they drilled and blasted through it. Belonging to the 99 out of a 100 that probably had never heard of alunite, they threw it into the dump and continued their search for gold. A keen observer, a prospector named Ole Larsen, belonging to the one out of a hundred class, suggested alunite. A chemical engineer, Mr. W. T. Schaller in the Government employ, made an investigation and analysis which was published by the United States Geological Survey, December 18, 1911, in Bulletin No. 30, which demonstrated the feasibility of extracting potassium sulphate from the pink spar. At this the Armour Fertilizer Company of Chicago "woke up," for they needed potash to compete with the German market, and developed on a commercial scale the process Schaller had theoretically worked out. Under the wing of their Mineral Products Company, the Armours acquired claims in the Tushar Mountains and erected the first mill in this country for the treatment of alunite, making its first shipment of potassium sulphate of 28 tons, said to be 93 per cent pure, to the Armour Fertilizer Company's works at Jacksonville, Florida.

Since Schaller's report chemical engineers have been active in alunite and have largely if not fully developed its many uses and values in the commercial field. They have determined that the Tushar Mountain alunite is a double sulphate of aluminum and potassium from the treatment of which, in one way or another, it is possible to extract potash, aluminum and sulphuric acid. In order to show the importance of alunite through its components in the principal products of manufacture, as well as the supplemental derivatives into which the manufactured products may be divided note the accompanying diagram:

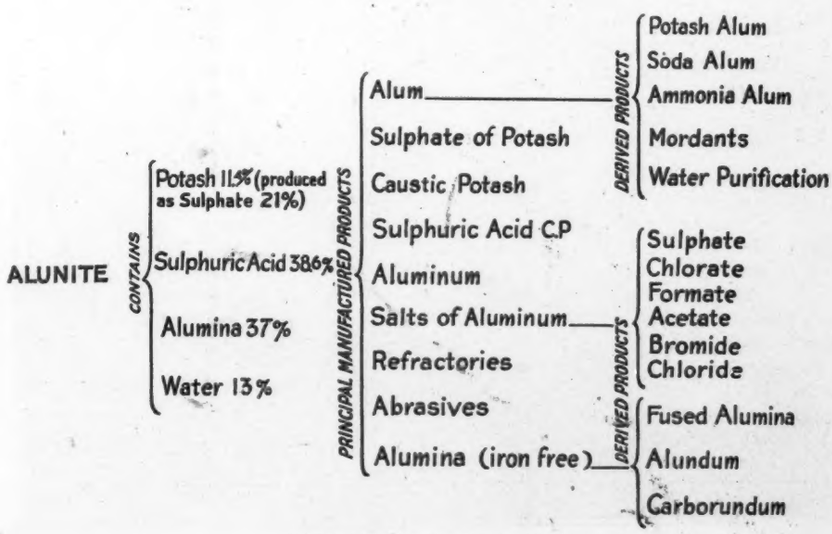
The value of the discovery of alunite will be seen from the fact that it opens an entirely new source of supply for its three active commercial products—potash, aluminum and sulphuric acid, in quantities of vast proportions, for there is quite a notable tonnage of this "pink spar" on the dumps and in sight opened up by the many tunnels, shafts and cuts—and probably a considerable supply—that has not yet been reached.

It is predicted that a revolution is due in the market for these commodities for, owing to the nature of the rock, it can be roasted and treated for its component parts at the minimum of expense. Whatever product of alunite is primarily sought to be produced, another product is obtained at practically no cost; thus, if the production of metallic aluminum is the primary object, sulphate of potash and sulphuric acid will be obtained as byproducts. If, on the other hand, the production of sulphate of potash is the primary object, then alumina—the basis of metallic aluminum—will be obtained as a byproduct and at no additional cost.

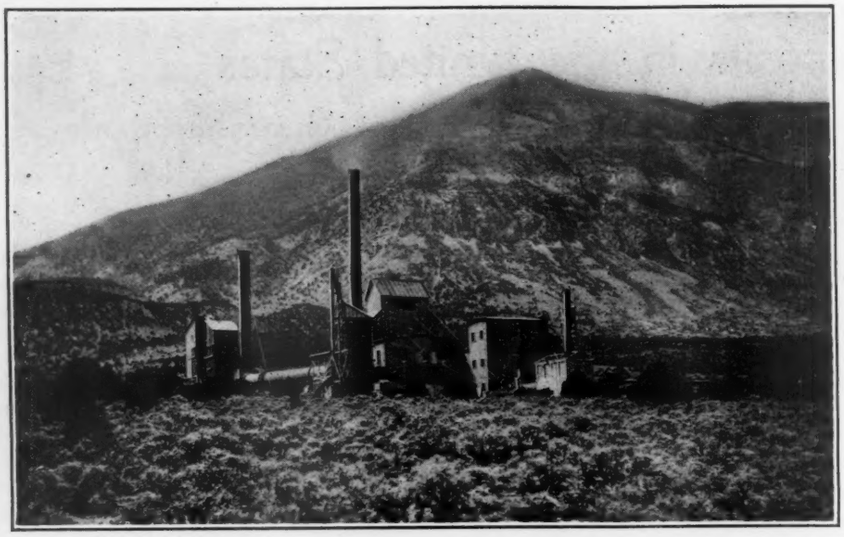
Sources of Alunite

According to Mr. Paul J. Fox, formerly of the Bureau of Soils, Department of Agriculture, the deposit of alunite in Utah is one of the largest in the world and also of a high degree of purity and will not be of much difficulty to work. Since gold often occurs associated with alunite there have been frequent discoveries of that mineral from time to time by gold seekers in various sections of the United States and elsewhere. The deposits that compare most closely with those of the Marysvale district are at Tolfa, Italy. The largest of these is the Providenza vein which has been worked to a depth of 300 feet. These deposits, known and worked since the Thirteenth Century, have a chief value in Europe as a producer of alum which enters the market in competition with artificial alum made from German potash. The volume of the Italian alunite, however, is too small and scattered and too poor in quality to compete with the product found in the mountains of Utah. In Australia there have been several alunite veins discovered by gold miners, and near Sulphur, Nevada, alunite has been found and some development work done. In every instance the quantity has been limited and the grade inferior. Considerable possibilities may yet be realized in the development of the alunite deposits of Marysvale and they may well repay efforts to exploit them.

Geologists say the Tushar Mountain alunite is a volcanic emission from Mount Edna, a long extinct crater, and that the alunite deposited nearby is of the purest quality, becoming contaminated as the lava flowed out over the adjoining country. Mount Edna is on the property of the Florence Mining and Milling Company of Philadelphia where Ole Larsen originally discovered alunite. Nearby is the property of the Mineral Products and the Swift Companies of Chicago. Several other companies are working or have worked in alunite in this general district since Schaller's discovery; the Utah Potash Company near Belknap; the Pittsburgh Utah Potash Company which controls deposits in Deer Canyon near the Sevier River; the American Smelting and Refining Company at Yellow Jacket near Twin Peaks, and others. Some are developing for alum; some for potash; some treat the ore on

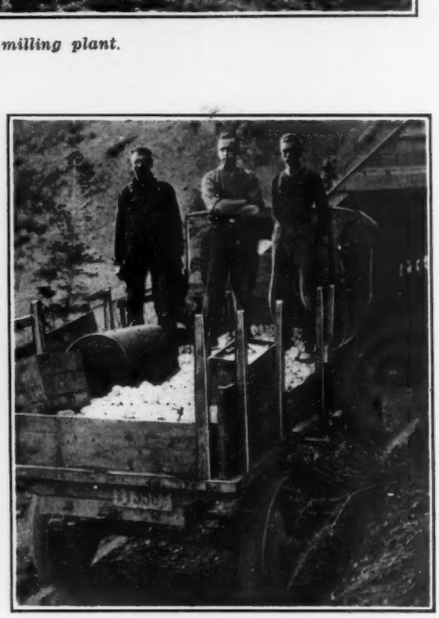


ALUNITE—ITS COMPOSITION, PRINCIPAL PRODUCTS AND A FEW OF THE NUMEROUS DERIVED PRODUCTS.

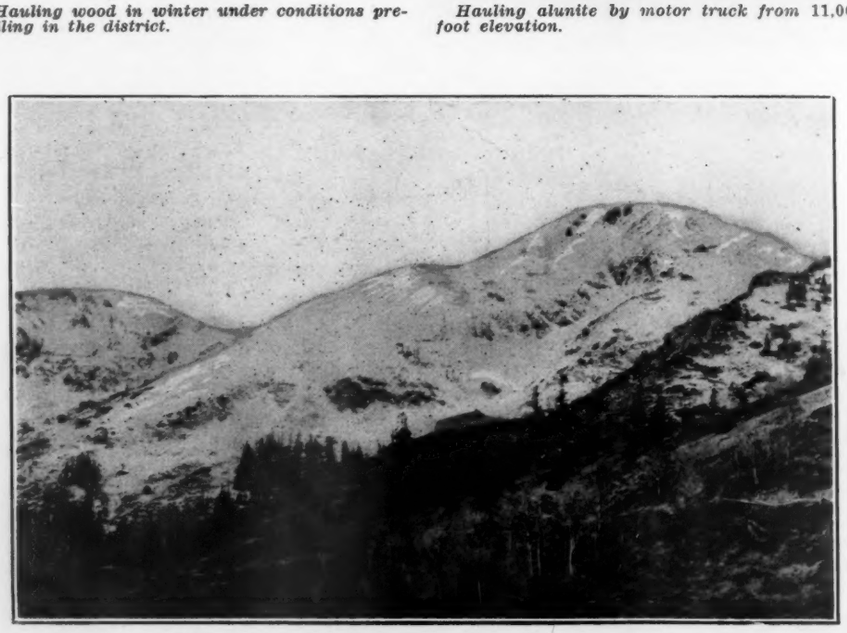


A Florence milling plant.

Hauling wood in winter under conditions prevailing in the district.



Hauling alunite by motor truck from 11,000-foot elevation.



Topography of ground situated in the Marysvale district.

the spot, while others ship it away for treatment. On account of their proximity to the original source of supply—the Edna Peak—the first three companies are the only ones operating in pure alunite.

By far the largest of these properties is that of the Florence Mining and Milling Company. This company controls and operates 89 proved claims of 20 acres—1780 acres in all. Its workings consist of 50 shafts, tunnels and cuts aggregating nearly two miles in length into the mountain. Nearly all of these openings are in alunite—and a large tonnage at least—in sight. Partial developments on other claims show still greater quantities. The owners say but little about the latter, however, partly because the exact quantity has not yet been proven, and partly because they say this tonnage is sufficient for any reasonable man to ask for at one time.

At the base of the mountain on the highway the company has its 50-ton lixiviation plant where the ore comes tumbling down the mountain in chutes from the tunnel mouths far above, and is crushed, roasted and prepared for shipment. Power is supplied by the Telluride Power Company whose high-tension lines pass through the property. The treated ore is transported to the railway at Marysvale, twelve miles away, by trucks over the wagon road. When developments have reached the proper stage it is the intention of the company to install a cable tramway capable of transporting large quantities of ore at small expense, cutting down the distance nearly a half, so circuitous is the highway as it winds through the valleys.

The Mineral Products Company's property is smaller in size than the Florence which it adjoins, and its alunite in sight and in prospect is less in quantity though not proportionally so. It has, however, advanced far, commercially, and has placed potash derived from alunite on the market in large volume, its daily production being about 35 tons. Equipping itself for business while the war was on it enjoyed all of the prosperity that came to the potash industry during that period. During this time the company fully demonstrated to themselves and the trade generally that was closely watching, that alunite was all they had hoped it to be, and that the predictions of their engineers who conducted the original experiments and examinations were fully justified and verified.

On the properties of the Florence and Mineral Products companies the alunite occurs in such a solid, compact mass that little timbering is required. Drilling is done with Ingersoll-Rand stopehamers, using 1⅛ inch cruciform steel. Jackhamers are used for block holing of large boulders in the stopes and for sinking winzes.

Blasting is done with 40 per cent straight dynamite and 40 per cent gelatine. Air for drilling is supplied at 90 pounds pressure by compressors having capacity of 1,050 cubic feet of air per minute. A 30 degree Beaume distillate is used for fuel. From the stopes of the Mineral Products property the ore is drawn in twenty cubic foot capacity cars and delivered to the loading bin of an aerial tram-

way, 6,200 feet long, which delivers the ore in 6½ cubic foot capacity buckets to bins at lower terminal, and from there is hauled by wagons to the mill, 4½ miles away.

Both the Florence and the Mineral Products properties have long since passed the mining development and promotion stage. They have fully demonstrated that there is enough alunite near the Edna crater to fulfil all the needs that can now be foreseen for years to come—and then a lot more. They have spent years doing this and in further developing the fact of the commercial possibilities of extracting potash, aluminum and sulphuric acid from a hitherto unknown source. In this operation, thus far, it has been experimental work that has, largely occupied their attention. They were learning what alunite was worth and how to make the mining and treatment of the ore pay at a time of high prices and large demand, and it is said that at least one of these companies made a good showing in the operation on a very small original investment.

But the scenes have shifted. The market for their product has been demoralized along with the market for all other products, and these companies are now reorganizing the working economies of their plants and operations to meet peace time competition in price from both at home and abroad—and the competition will be keen. Pioneering is usually a hazardous operation, but at least one of these companies had the rather unusual experience and good fortune of pioneering in a market whose intensive demand for their product practically eliminated the hazard.

Potash

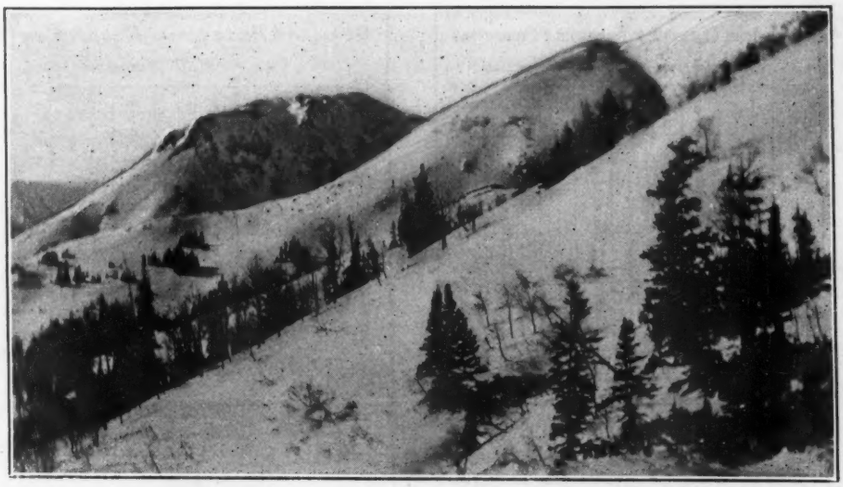
When the term "potash" is used it is understood to mean potassium oxide (K_2O). Potash salts are not used in the form of potassium oxide but as potassium sulphate, potassium chloride, etc. By the term potassium sulphate, is meant, potassium oxide, (K_2O), combined with sulphur trioxide (SO_3), making the compound (K_2SO_4). Potash salts are essential in numerous industries, the most notable being the fertilizer industry. The salts are used in the manufacture of glass, explosive powders, certain kinds of soap, and in the chemical industries including the manufacture of alum, cyanides, bleaching powders, dyestuffs, match tips and other chemicals. Note the following table.

POTASH IMPORTS

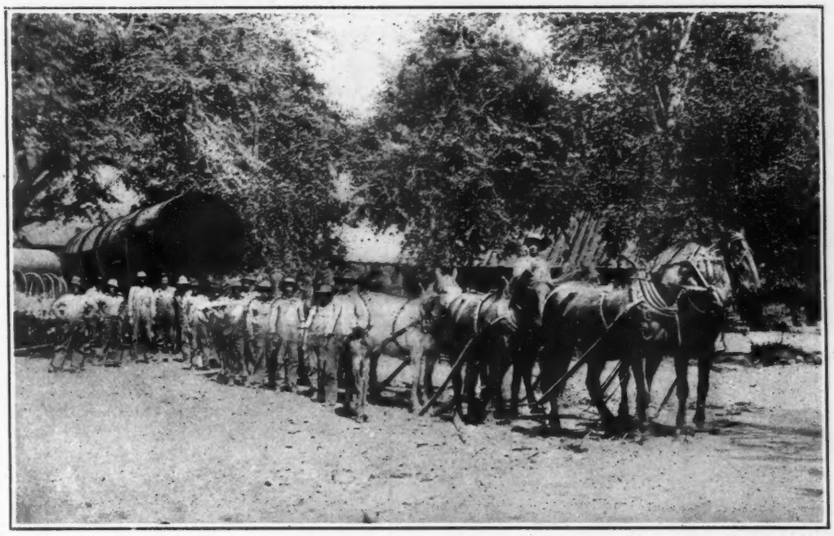
(SHORT TONS)

(From Reports of the United States Geological Survey.)

	Crude	Available K_2O	Value $
1905		129,084	
1906		155,974	
1907		144,351	
1908		136,057	
1909		173,220	
1910		179,780	
1911		174,446	
1912		153,678	
1913	1,092,588	270,720	18,073,865
1914	798,087	207,089	15,421,611
1915	116,686	48,867	6,258,348
1916	26,642	7,885	7,425,398
1917	25,287	8,100	7,788,406
1918	24,419	7,957	8,907,836
1919	160,846	39,619	10,191,816
1920	947,176	201,927	33,942,181

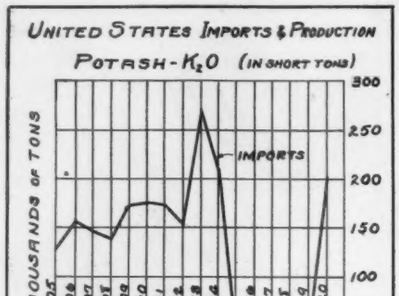


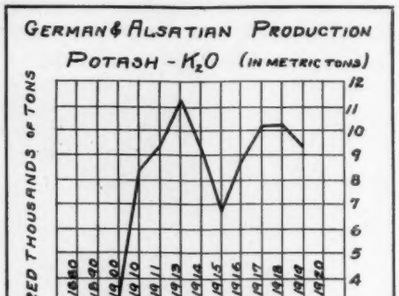
One view of a part of the Florence Mining and Milling Company.

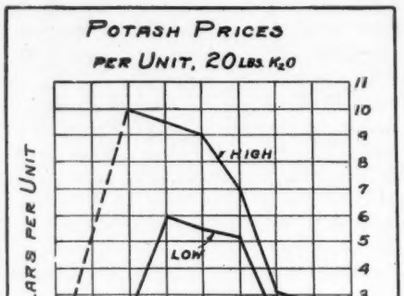


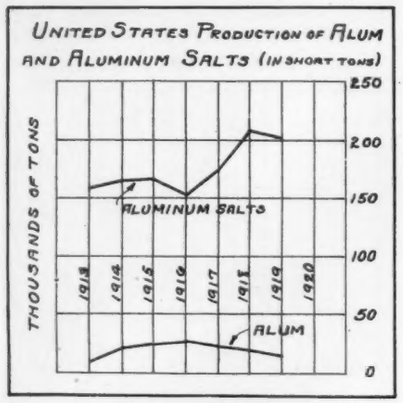
Hauling the big 110 foot rotary kiln to the mill. A section of this pipe measures 35 feet in length.

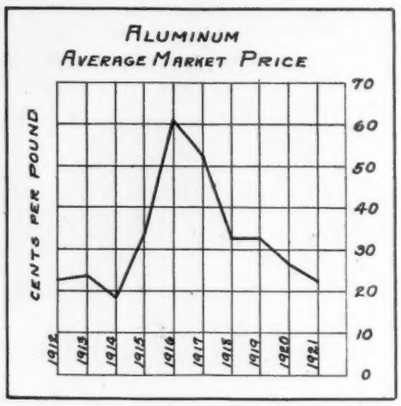
The man in the picture is Ole Larsen, a famous prospector and the discoverer of alunite. He is standing on a 60-foot solid alunite vein.

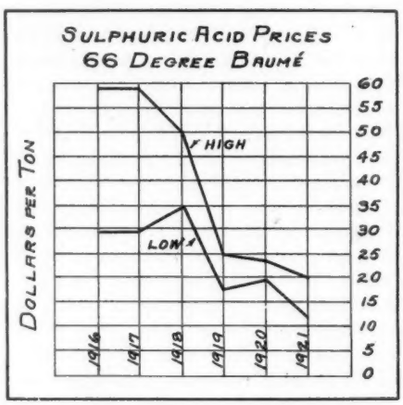










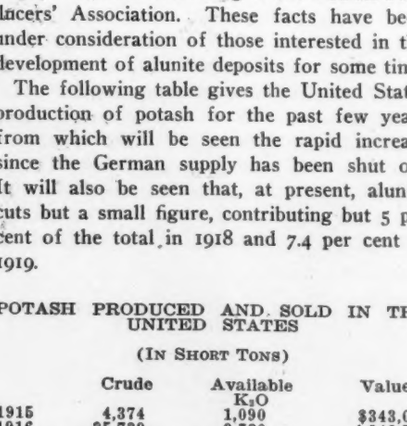


SAME, FOR THE FIRST SIX MONTHS OF 1921

U. S. Potash Producers Association

January	33,110	5,990	$1,063,552
February	29,667	6,857	1,189,677
March	22,949	5,951	1,113,963
April	8,720	2,334	419,565
May	5,116	1,399	244,210
June	534	231	33,421
Total	100,096	22,762	$4,064,388

Up to the war the use of potash was increasing rapidly but its use in this country has hardly begun. It is just commencing to strike the West and it is very likely that within a few years the total use throughout the United States will be double that of 1913. Stocks of potash held in this country are variously estimated at from 50,000 to 80,000 tons. According to the United States Potash Producers Association they are small compared with the potential demand. Reports state that this country used in 1920 at least 200,000 tons and possibly 225,000 tons. In 1921 the consumption will be far below that figure because of the so-called farmer's strike which was not so much of a strike as sheer inability to pay. The 1921 consumption of potash will, according to the best authorities, not be more than 75 per cent of the 1920 consumption, say 150,000 tons. Even this amount is close to three times the quantity said to be on hand. Next year, with fertilizer prices down, there is good prospect for a largely increased use of potash even, possibly, up to the 1920 consumption. In that event, what will become of the 50,000 or 80,000 tons now in stock and what will happen to prices? Many American plants are closed. Germany has stopped shipment, France has almost stopped, and stocks on hand are something like a quarter of the demand which



may be expected according to the Potash Producers' Association. These facts have been under consideration of those interested in the development of alunite deposits for some time.

The following table gives the United States production of potash for the past few years from which will be seen the rapid increase since the German supply has been shut off. It will also be seen that, at present, alunite cuts but a small figure, contributing but 5 per cent of the total in 1918 and 7.4 per cent in 1919.

POTASH PRODUCED AND SOLD IN THE UNITED STATES

(IN SHORT TONS)

	Crude	Available K_2O	Value
1915	4,374	1,090	$343,000
1916	35,739	9,720	4,242,730
1917	126,961	32,573	13,980,577
1918	140,343	38,580	15,839,618
1919	173,786	46,732	11,370,445

POTASH OBTAINED FROM ALUNITE RECORDED IN FOREGOING TABLE

(IN SHORT TONS)

	Crude	Available K_2O	Value $	Percent of Total
1918	6,180	2,621	1,276,774	5
1919	6,594	2,293	683,055	7.4

(From Reports of the United States Geological Survey.)

The price of potash has fluctuated widely, running as high as $10 a unit of twenty pounds in 1915 to as low as $1.85 in 1920 and approximately $1.35 this year, as will be seen from the table.

WHOLESALE PRICE OF POTASH

(PER UNIT OF K_2O)

	High	Low	Average
1915	$10.00	$2.30	$5.90
1916	9.80	6.00	7.60
1917	9.00	5.50	7.60
1918	7.00	5.20	6.30
1919	3.25	2.00	2.70
1920	2.80	1.85	2.40
1921			1.35

In pre-war times the German product sold at around 75 cents a unit, and it has been found that the use of fertilizer by the farmer is largely an economic problem. When potash is high he uses little; he goes without it. This will be seen by reference to the table below which gives the approximate use at different prices:

With Unit Price of	Probable yearly use
$5.00	45,000 tons
2.50	90,000 "
2.00	112,000 "
1.50	150,000 "
1.00	225,000 "
.75	300,000 "

—From "Mineral Industry," 1919.

With the advent of settled business conditions it is the hope of alunite workers to produce potash at a price low enough to bring out the maximum of demand from the farmer.

It will be seen from the above and from the tables and graphs that the potash industry of the United States has long enough been dominated by Germany and, on account of the numerous and extensive uses of the potash salts it is essential that the industry be permitted to establish itself firmly in this country. Great strides have been made in this direction but, like all "infant industry" it should have a little protection at the hands of Congress, and the modest tariff of 50 cents a unit for the next two years, graduated down to 40 cents, 30 cents, and twenty cents in the fifth year after which time no protection will be needed, seems most reasonable.

Alumina

The alunite deposits of Marysvale contain 37 per cent of aluminum oxide. Alumina is a white powder and is the material from which the metal, aluminum, white in color and light in weight, is made. Alumina is 53 per cent aluminum. The nearest thing occurring in nature to alumina is bauxite, found for the most part in Georgia and Arkansas. Bauxite, according to Fox, contains 50 per cent alumina (26.5 per cent metallic aluminum), the rest being clay, earth, sand, iron and water. It is formed in superficial deposits in pockets running into clay and requires a chemical analysis to determine how much alumina it contains. Bauxite is contaminated with iron, silica and lanthanum which increase the expense of making the pure alumina necessary for manufacturing aluminum. None of these impurities have any commercial value, their removal but adding to the expense.

Undoubtedly more interest will be taken in developing known deposits of aluminum minerals and prospecting for others, inasmuch as the development of the airplane engine will require large quantities of this exceedingly light material. Other uses of aluminum and its alloys of course will require large quantities. It is now a known fact that combined with certain other elements the tensile strength of aluminum can be largely increased and therefore because of its comparative lightness a good many other fields may be opened up for its use.

Alunite is alumina mixed with sulphate of potash, or alumina mixed with alum, according to the way it is treated. Leaving aside the sulphuric acid, the potash and alum are both valuable, and can be separated at a small expense. The market for alumina in the manufacture of aluminum is world-wide and active search for new sources of supply is now going on.

An aluminum manufacturer, using the Mount Edna alunite, has the alumina free if he chooses to so regard it for the alum, potash and sulphuric acid will, according to the best of authorities, more than pay for all mining, transportation and manufacturing charges. This fact would constitute a great advantage to producers of alunite when the market of either potash, alumina or sulphuric acid is considered. A manufacturer can, if he desires, warehouse at least one of the products and wait a favorable market while covering himself with the other.

The following table shows the imports, exports and apparent consumption of aluminum, taken from government reports:

Alum and Aluminum Salts

Although not met with in quantity in ordinary life alum is an important and widely used article in the chemical industry. It has been a staple for a long time and its application is rapidly increasing in this country on account of the development of the dye industry. Alum has other uses, in making bread, in lithography in paints and enamels, textiles, printing, paper, leather, tanning, Portland cement and in softening water. Various substitutes, mostly on account of their cheapness, have come into use for alum, principally aluminum sulphate, of which the quantity consumed is far greater than alum.

Alunite is considered by many, according to Fox, to be incomparably the best material for the manufacture of both alum and aluminum salts. He considers that, properly pushed, it will drive out every competitor, domestic and foreign.

A certain strategic, almost monopolistic position in the market belongs to the owner of an alunite property. Owing to its freedom from iron and to the small expense of making it, alunite yields the preferred alum at as low a price as aluminum sulphate can now be sold.

Sulphuric Acid

When alunite is heated it yields as an exit gas 29 percent of its weight of sulphur dioxide and oxygen in the proportion of one of the dioxide to one-half of oxygen. The sulphur dioxide-oxygen exit gas is pure and free from undesirable chemical constituents, is of high concentration, and contains all the oxygen necessary to make sulphuric acid. These salient facts, says Fox, make it apparent that the contract process is the advantageous one for making alunite acid, and that alunite can cheaply produce without any purification of the gas, the most perfect sulphuric acid possible to prepare, chemically pure, and suitable for use in making acid phosphate, baking powder and the like. Alunite gives off three-quarters of its combined sulphuric acid in heating, the other quarter remaining with the potash to form the potassium sulphate. The total sulphuric acid is 38.6 per cent, the amount yielded in heating is 29 per cent of weight of the raw alunite.

Prior to the war the yearly output of crude sulphuric acid calculated on the basis of 50 degrees Béaume was about 3,600,000 tons. The war raised this figure to as high as 9,600,000 tons which fell off again in 1919 to approximately the old amount. The industry is now suffering from the decline in all lines of business and a surplus stock apparently exists in this country which has driven the price of the crude product down to a very low-point —$10 or $12 a ton of 60 degree acid and about $18 to $20 for the 66 degree, although the chemically pure acid is worth, today, around $200 a ton, with a comparatively limited demand.

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The great mass of alunite of the Marysvale district is unique in itself and offers rare business opportunities. Besides being the only body of alunite in the world of industrial importance, it is so immense in size that it is capable of forming the basis for a whole series of industries for an indefinite number of years in potash, aluminum, alum, aluminum salts, alumina, sulphuric acid and their derived products. It would be no exaggeration to call it a monopoly.

Considered as a mineral deposit alunite, also, is unique in that there is no need of assaying for values for the whole vein is used.

A further advantage is claimed by the owners of the Marysvale alunite near Mount Edna in that it guarantees that prime requisite for a manufacturing industry of a practically unlimited supply of raw material of uniform quality. In this it differs from bauxite where continual change is the rule. It offers no difficulty in mining or grinding and can be roasted at a moderate temperature which means economy in fuel. It can be stored and shipped without deterioration, and the processes of

ALUMINUM

UNITED STATES PRODUCTION, IMPORTS, EXPORTS AND APPARENT CONSUMPTION

	Primary Metal	Secondary Metal	Imports	Exports	Apparent Consumption	Imports Lbs.
1912	$7,400,000		$3,541,591	$1,347,621	$9,593.970	
1913	9,450,000	$2,199,480	3,845,611	966,094	14,528,997	
1914	10,080,000	1,673,140	2,801,211	1,546,510	13,007,841	15,964,042
1915	16,280,000	5,802,100	1,808,193	3,682,117	20,208,176	13,765,172
1916	33,900,000	23,430,200	1,785,870	15,417,134	43,698,936	8,200,528
1917	45,882,000	16,711,800	56,890	14,586,467	48,064,223	1,904,000
1918	41,159,000	10,113,600	554,586	10,869,388	40,957,798	1,503,776
1919	38,558,000		4,568,595	3,890,326		6,822,616

(From Reports of the United States Geological Survey.)

WORLD PRODUCTION OF ALUMINUM

(METRIC TONS)

1913	29,500	in United	States;	79,590	Total
1914	40,600	" "	"	84,957	"
1915	45,000	" "	"	88,394	"
1916	63,000	" "	"	130,626	"
1917	90,700	" "	"	173.240	"
1918	102,000	" "	"	208,215	"
1919	90,000	" "	"	173,000	"
	*115,000	" "	"	257,000	"

*Estimated Capacity.

AVERAGE PRICE OF ALUMINUM

(CENTS PER POUND)

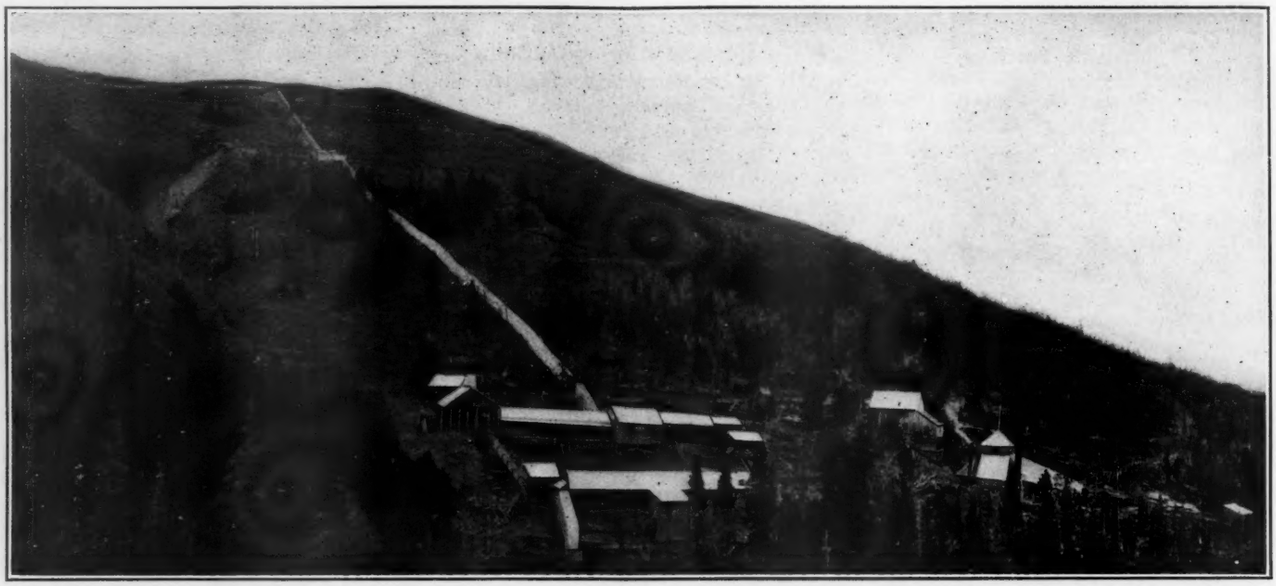
1912	22.01	
1913	23.64	
1914	18.63	
1915	33.98	
1916	60.71	
1917	52.00	
1918	33.00	
1919	27.00	
1920	22.75	
1921	22.75	June 30.

SULPHURIC ACID PRICES: 66 DEGREE (CRUDE)

(DOLLARS PER TON)

	High	Low
1916	60	30
1917	60	30
1918	50	35
1919	25	16
1920	24	18
1921	20	12

—"Oil, Paint and Drug Reporter."



One of the camps and the mountain plant of Florence Mining and Milling Company, developing a large body of high grade alunite near Marysvale, Utah.

working up, unlike much chemical manufacture, do not require large and expensive plants or great capital outlay.

When the business clouds disappear and industry again resumes a normal basis, manufacturers in alunite expect to find a commercial advantage in the development of deposits of this mineral for its products and derivatives for the simple reason that, in working for one of the products, the others are produced at practically no additional cost.

DAME NATURE vs. THE ENGINEER

(Copyright, 1921, by W. F. Schaphorst).

NATURE IS often called Dame Nature, which means that Nature is a woman. I believe it because women can't be understood and neither can Nature.

For example, wherever you go or whatever you do you invariably have to fight for what you want. Nature has a tendency to give you the opposite of what your heart craves.

Piston rods and cylinders are made nice and smooth in the first place and it is our desire to keep them so, but little old Dame Nature takes a hand in the affair and does all she can to make Sir piston rod and Sir cylinder walls rough. Same is true of bearing, valve surfaces, the rails in our railways, and so on ad infinitum.

On the other side of the fence we have friction drives that were made rough in the first place, but Dame Nature is opposed to roughness there just for the sake of contrariness, and Lo and behold, the surface soon becomes smooth. A file is made rough, but does it stay rough? Even gears have a tendency to wear down smooth. Mother Nature sometimes tries to make gears smooth by breaking the teeth off. Very often, you see, she is hasty and doesn't use good judgment.

If you want to keep a thing sharp, you can't do it without constantly opposing Nature. If you want to keep a thing dull, look out or it will get sharp.

Nature is a Woman, without doubt.

COMPRESSED AIR FOR A WINDOW DEMONSTRATION

A concern manufacturing ball bearings gives in a shop window in London an interesting demonstration of the elimination of friction. An ordinary electric fan is placed in close proximity to two four-bladed fans staggered one behind the other. On the spindle of the latter a little pulley is fixed, from which a belt is taken to a large pulley wheel on an overhead shaft, about three inches diameter, running entirely in ball bearings with several other large pulleys, and from two of these a belt is connected with more machinery on the ground driving a bevel gear, this in turn driving a circular group of large ball bearings. The working of all this series is done entirely by the pressure of air. The electric fan produces a current of air which impinges on the blades of the second fan and keeps the whole train in motion at a good speed. The belts used to drive this combination are made of ordinary cotton tape and thin string.

BENEFITS OF COLD STORAGE

A COLD STORE manager reports the receipt of 4,000 bags of coffee for storage, and on inquiring the reason he was informed by practical men in the coffee trade that they thought the effect of cold storage eliminated shrinkage and preserved the valuable color of green coffee, called in the trade "blue coffee." The same manager says that he has been informed that valuable silks can be better preserved in cold storage than they can in ordinary warehouses, as the sheen of the silk can be easier retained. He found on investigation that the practice among large silk merchants was to keep their silks in cool basements. Such being the case, it is evident that a modern, dry, efficient, clean, and attractive cold storage room must be a far better place in which to store them. It is well known also that furs when not in use are kept in better condition by cold storage than by any other means.

SUBMARINE OXY-ACETYLENE TORCH

An improved form of oxy-acetylene torch has, according to *La Nature*, been evolved in the French Navy in the process of salving vessels lost during the war. A small bell-shaped vessel surrounds the oxy-acetylene flame, and is kept supplied with compressed air. After the flame is alight and the stream of compressed air established the torch may be plunged into water without being extinguished. If by accident the original form of blow-pipe was extinguished, it was necessary for the diver to ascend to the air to light it again. A tube containing an alkaline metal and an oxidiser is now attached to the torch, and can be moved to the mouth of the bell. On removing the cap from the end of the tube the chemical action of the water on the mixture produces a flame which re-lights the torch. The addition has greatly increased the number of underwater uses to which the torch can be put.

A tunnel is being driven through 100 feet of rock a few miles east of The Dalles, Ore., which will remove the last obstruction on the Columbia River highway between Astoria and Pendleton. It is reported that the tunnel is practically completed and will be ready for operation in a few days.

A new fire boat costing in the neighborhood of $222,000, is being built by the Standard Shipbuilding Corporation for the City of New York. The new fire boat will be 121 feet long, 27 feet beam, fourteen feet nine inches depth, and will have a speed of twelve knots.

"LITTLE TUGGER" DERRICK

NECESSITY recently caused the invention of an inexpensive derrick and, at the same time showed another novel use of the air hoist.

Fire gutted the 600-ton mill of the Silver King Coalition Mines Company. This mill concentrated the ores from the company's various mines which are located along the strike of the ore zone at Park City. Utah, about 35 miles southeast of Salt Lake City.

Two "Little Tugger" Hoists were used in the construction of the derrick for clearing away the debris to make room for the new mill which is to be erected. This derrick was used to lift all of the heavy material. The hoists are small, compact drum hoists operated by compressed air or steam. Originally they were used in the company's mines—they were first put on the market as portable mine hoists.

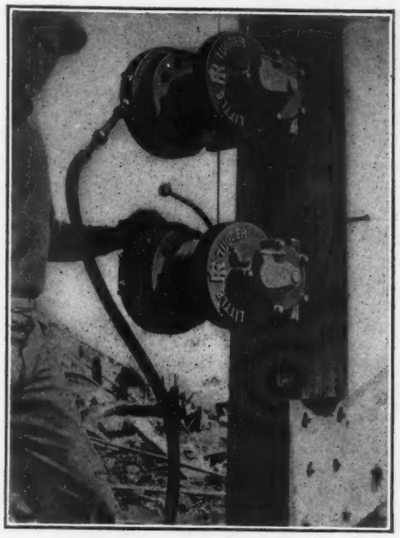
Following is a description of the derrick and the work:

The mast, a, and the boom, b, were both made from telegraph poles. The mast is carried at the foot by the pivot, d, held by the guy ropes, e. The boom is pivoted at the lower end of the mast. The rope, f, is connected with the upper hoist and passes over the sheave, g, at the top of the mast and through the pulley, h, at the mast head and, i, at the top of the boom. This rope varies the angle of the boom.

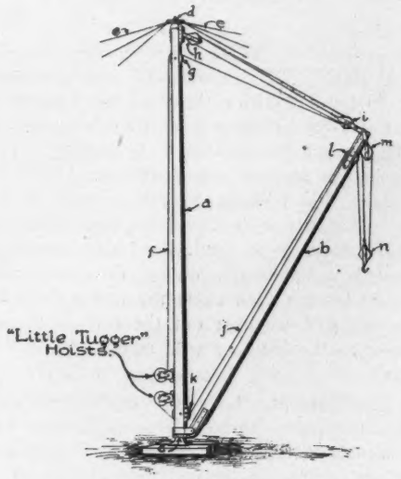
The hoisting rope, j, is connected with the lower hoist and passes under the sheave, k, on the mast, over sheave, l, on the boom and through the pulleys, m and n. This is the rope which suspends the load.

The derrick is swung by hand although another "Little Tugger" could do this work also if it were desired. In this case the derrick would have to be furnished with a bull-wheel.

The installation photograph shows the derrick in action. One-half of a 64½ Marcy Mill has just been lifted clear of the ground. It was used in clearing away about 90% of the wreckage from the fire. With the pulley arrangement shown, the derrick is capable of lifting approximately a 3-ton load. This, of course, may be varied to suit conditions.



Two "Little Tugger" hoists mounted on derrick mast used to clear debris at burned concentrating mill of the Silver King Coalition Mines.



Little Tugger derrick.

"Little Tugger" derrick has lifted the one-half of a No. 64½ Marcy Mill clear of the ground at the burned concentrating mill.

A PANAMA CANAL FISH INDUSTRY

THE LARGE dry dock at Balboa, as we learn from the *Panama Canal Record*, is showing an unexpected profit from the fish entrapped. When the gates of the dock are opened for the docking of a vessel a number of fish usually swim in; and when the dock is pumped out they are left stranded on the floor. During a recent docking a school of fish swam in. When the dock was unwatered the floor was covered with them. In addition to those which the men took, and some 650 lb. taken by the Commissary Division, between two and three tons were dumped over the gates into the open sea. They were scooped into large buckets which were swung up and over the gates by a crane operating from the side wall of the dock. Most of them recovered and swam away. The Commissary Division realized 490 lb of cleaned fish, which were sold as second-grade stock at 11c. a pound.

ORE BREAKING AT THE MASCOT MINE

By H. A. COY
Supt. of Mines, American Zinc Co.

AMONG THE number of stoping systems tried out during the early development of the Mascot property were the shrinkage and the underhand systems of stoping. The shrinkage system was discontinued early in 1914. The underhand system was adopted as standard, with few exceptions where it was necessary to work the breast stope (or over-head method), owing to development drifts being driven along the foot-wall, which necessitated working out the ore on the sill floor to the hanging wall and a top heading cut.

The Mascot ore body has a dip of from eighteen to twenty degrees. This necessitates considerable development in the foot wall with raises penetrating the ore body at intervals to be used as ore chutes. As the ore will not deliver to the sill floor, a sub-level tram is usually established at a point where the greatest amount of ore will deliver to the shovelers on this particular level.

In working the underhand system, as applied to the Mascot property, the hanging wall is first encountered. A heading, usually from six to eight feet in height, is cut along this hanging wall, extending from pillar to pillar, a distance varying from 25 to 60 feet depending entirely on the condition of the roof.

The headings are advanced with the formation following the hanging wall. The ore breaking in the heading usually consists of a series of slabbing rounds of from three to six holes with a burden of approximately four feet in which the depth of the holes average approximately ten feet. These holes are drilled in such a manner that the breaks can be carried in the rail fence fashion from pillar to pillar, so that a machine working in one direction will leave the breaks in such shape that the same system may be duplicated by a machine working in the reverse direction.

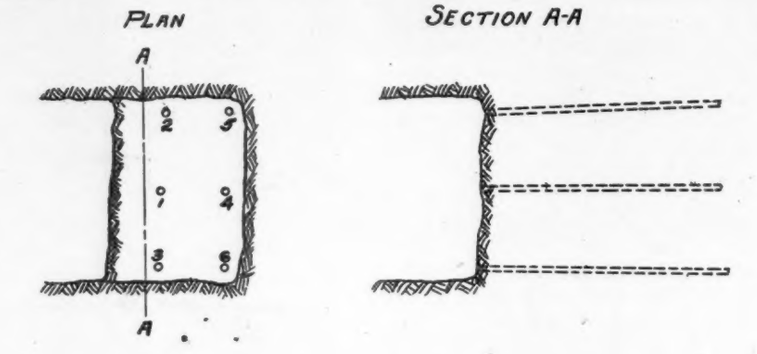
It is very important, due to the thickness of the Mascot ore body, that the roof be left in ideal shape before the bench is removed as it is very difficult to reach the roof again after this bench has been stoped out. In fact, failure to do this often necessitates setting ladders from 60 to 80 feet in height in order to make the roof safe.

After the heading has advanced from ten to fifteen feet the bench is removed by drilling a series of vertical holes from pillar to pillar at an average depth of ten to twelve feet with a burden of from four to six feet. The terrace system is used. Each terrace is left of such width that drilling can be carried on in a safe manner. Practically the entire bench is removed in this way, with the exception of that lying close to the sill floor, or along the foot-wall which is usually removed by snake holes, or horizontal holes drilled from a tripod. In this way, a floor low enough to allow advancing the tracks as near the bench as possible is obtained and shoveling platforms may be laid before stoping is started again from the top of the bench.

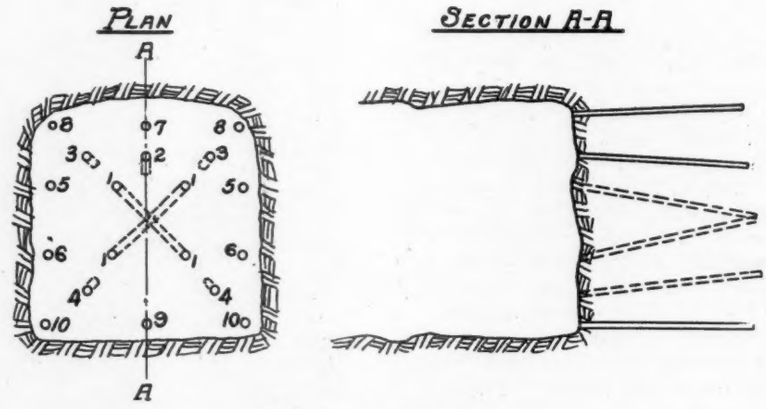
The drilling equipment for this type of stoping consists of hammer drills of the mounted type, working from a 6-ft. post using a 30-in. arm. The bench work, in drilling vertical holes, uses the same type of machine, but taken off the shell and having handles bolted to the back head. This makes it possible to carry on the work without having two types of machines in each stope. Also this combination of drills is desirable on account of using only the one kind of steel, which simplifies the sharpening considerably.

It has been the practice in all stope work throughout the Mascot mines to use one stick of powder to each foot of hole drilled, regardless of whether this hole was placed in the heading or on the bench of the stope. After making a number of tests on various grades of powder and size of sticks, we found that it was hard to break the men of this practice. We are now placing our rounds in such shape that we may secure the greatest amount of tonnage from this amount of powder.

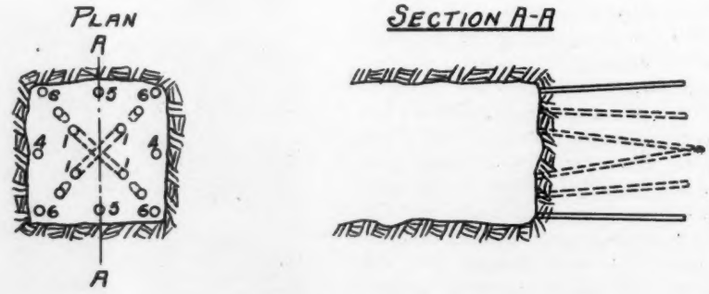
The majority of the development work carried on at Mascot is by contract and the system of drilling out the headings is not speci-



STOPE HEADING OR SLABBING ROUND



DRIFT HEADING



RAISE HEADING

NOTE NUMBERS INDICATE ORDER OF FIRING

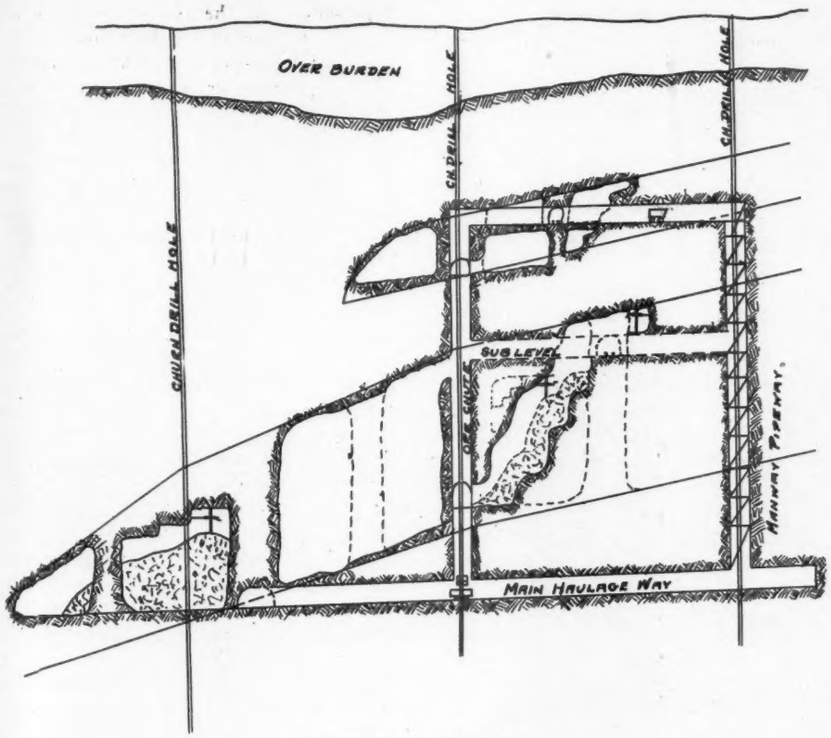
fied by the company. It has been found that the pyramid cut is used almost entirely by the contractors, with from four to five relief holes. The number of roof holes and lifting holes depend entirely on the size of the drift. The average number of holes for 7x7 ft. drift is from nineteen to twenty and in an 8x8 ft. drift from twenty to twenty-one. These holes are drilled nine feet in depth and usually pull a heading measuring about seven lineal feet. This requires from 1½ to two cases of 30 per cent, 1⅛x8 in. gelatin dynamite per heading.

The raise headings are drilled practically the same as the drift headings. The size being only 5x8 ft. in the clear makes it possible to pull a heading of four lineal feet with sixteen holes drilled approximately five feet in depth, and requiring from one to one and one-quarter cases of 1⅛x8 in. 30 per cent powder.

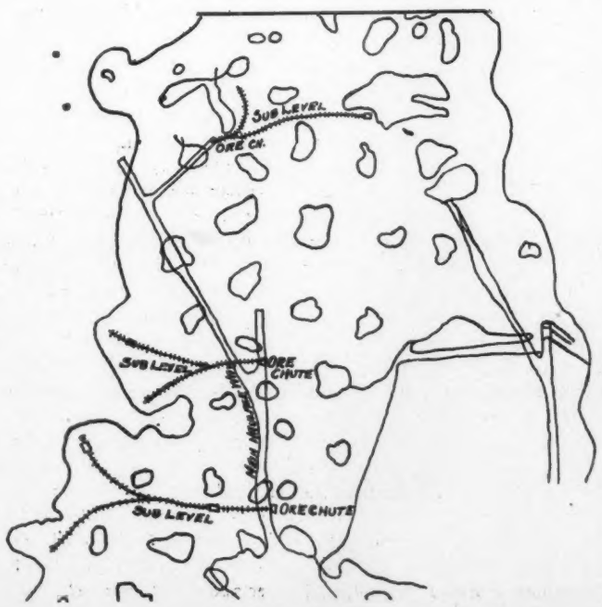
In our development drifts the late model hammer drills are used, two machines working from vertical posts. Under the present system, the heading will be drilled out and shot on one shift and mucked out on the following shift, making it possible to advance a 7x7 ft. drift, from 35 to 40 feet per week.

SOME FUEL EQUIVALENTS

1 Gallon Fuel Oil.....20 Pounds of Coal
5 Gallons Fuel Oil.....1,000 ft. Coal Gas
8 Gallons Fuel Oil.....1,000 ft. Natural Gas



Longitudinal section view.



Plan view.

WIND DRIVEN ELECTRIC POWER STATIONS

THE FOLLOWING article we take from a really valuable publication: *Engineering Progress.* It is all in English, although the publication is printed in Berlin, which fact may not be generally known.

The greatest and most important advance in the utilization of wind power has been made by the erection of reliably working wind-driven power stations. As a result of very exhaustive work, success has been attained in bringing out an arrangement which has been patented and which combines simplicity with automatic operation and reliability of working. A shunt-wound dynamo with counter compound windings and commutating poles is used. To prevent return currents from the battery a polarization cell and a relay-switch are employed, in which latter winding is connected in series with the cell. As the cell is used only at the beginning for very weak currents and for short periods, it may be small and cheap. The main circuit from the dynamo or the battery which is closed by the return current cut-out is arranged parallel to the polarization cell.

When this circuit is closed, the polarization cell is dead and a second winding of the relay, which is arranged in the main circuit, keeps the circuit closed as long as the voltage of the dynamo exceeds that of the battery. On the speed of the turbine decreasing, the automatic device receives no current and switches the main circuit off. The cell then begins to conduct the weak current which is still present and when this comes to zero, the return current will be blocked by the cell.

An installation of this kind with a wheel of 8.5 m. diameter has been subjected in 1911 to a six months' test at the grounds of the "Technische Hochschule" in Dresden, where the plant has been working all the time without disturbance, very often also at night time. With a wind of 5 m. per sec. velocity, a useful effect of 2 k. w., and with 7 m./sec. such of 3.85 k. w. have been attained.

Whereas up to the present time special types of dynamo have been indispensable, which had to be suited to the irregularities of the wind, more recent experiences carried out have proved that it is also possible to employ ordinary direct current machines in combination with wind motors.

According to a recent report by the Bureau of Mines, Southern Illinois and Kentucky are credited with approximately 90 per cent. of the fluorspar production of the United States. A small amount of high-grade acid spar is obtained from the ore by hand sorting; the greater part, however, is recovered by jigs and tables as gravel spar containing approximately 85 per cent. calcium fluoride. In the jigging and tabling operations, galena is recovered, and enough silica and calcite are removed to raise the calcium fluoride content of the gravel spar to 85 per cent. However, the removal of silica and calcite results in a large loss of spar. With increasing depth in the mines, zinc sulphide, sphalerite, is encountered in increasing quantity and the removal of this has become a serious problem.

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Secretary

FOREIGN CORRESPONDENTS

Paris
BEN K. RALEIGH
8, Rue Saint-Florentin, Place de la Concorde

London
ROLAND H. BRIGGS
No. 165, Queen Victoria St., E. C. 4

Berlin
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Madrid
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EDITORIALS

PLENTY OF BIG WORK FOR COMPRESSED AIR

TO STATE the case as briefly and as mildly as possible, we may say that the accustomed industries of the world are moving just now at a speed and with a push somewhat below the normal. Not every willing worker, doing all that his hands find to do, can be said to be doing it with his might according to the time honored injunction. There is a palpable reserve of unemployed energy in many lines, and there are those who see little prospect of an immediate resumption of the old time rate of accomplishment.

The tone of the above will be recognized as all too familiar, and we are getting tired of it. It is not altogether a truthful view and it does not apply universally to the present situation. In the line of the world's biggest engineering there is more work under way and there are more schemes far advanced toward a sure beginning of constructive activity than, individually and collectively, it has ever before been possible to enumerate at one time. It comes especially in our way to be saying this because the undertakings, present and prospective, which we have in mind and some of which we purpose here to mention are those in which compressed air is a prominent, or, if you please, *the* most prominent and responsible agent employed.

For our present purpose we need not go outside the United States, always remembering that the other engineering nations of the world also are planning and working along the same lines so far as their financial limitations permit.

Our first citation is close at hand. This is the twin vehicular tunnel under the Hudson from Canal street, New York, to Jersey City. Tunnels have become such a familiar old story to Gothamites that the actual beginning of active work has been scarcely mentioned by the secular press although it had unusually interesting features.

The normal way of beginning such tunnels as these would have been to start excavating horizontally at a considerable distance from the river and to gradually descend until the dock line and the tunnel level were reached at the same time. In this case, however, the descending approach on the New York side was for the time ignored and the driving of the tunnels was commenced by the sinking of two pneumatic caissons very near the river and starting the tunnel excavation from them.

These pneumatic caissons, built of boiler steel, say 40 feet square with the height about the same, painted red and each surmounted by two air-locks, were quite spectacular for a week or two, but one of them was sunk out of sight below the street level in two or three days, and the other caisson a week or so later, the suddenness of their disappearance suggesting the rapidity with which the work will be pushed, and similarly from the other side of the river. The building of these tunnels is a job of the first magnitude in itself and in connection with the service for which they are to be used entails the additional serious problem as to the means of ventilation, the complete and satisfactory solution of which will be awaited by the world with interest.

Before these tunnels are completed and in use another and probably a greater enterprise will be well under way: the tunnel to Staten Island, the principal delay at present being in the determining of its precise location. It will be much longer than any of the other New York tunnels and special difficulties may be encountered in the character of the material to be penetrated, but skill and time and money will certainly drive it through. The tunnel after all would seem to promise inevitable disappointment, notwithstanding the engineering achievement of it, on account of the length of travel in it and its entire inadequacy for the magnitude of the traffic to be developed and then accommodated by it.

It has been very easy and has become more or less habitual with the general public to think of tunnels for crossing the larger and busier waterways as so much cheaper than bridges and generally also more quickly constructed. As to cost, nothing could be more incorrect, a bridge being much the cheaper. A great bridge may cost, say, as much as four tunnels, but if it has the capacity of more than a dozen tunnels there is nothing more to be said, and then there is the sunlight, the free air and the general sense of security thrown into the bargain.

We are beginning to recognize the bargain and are moving to seize it. A new bridge era would seem to be upon us. It may be more than a coincidence that at the present moment we are able to mention at least three bridges, fully planned and assured of construction almost immediately, each of which in dimensions, in capacity and in cost will far exceed any previous bridge in the history of the world.

Those three bridges are all of the suspension type, and it is hardly necessary to remind our readers that compressed air, in the sinking of the pier foundations and in the manipulation of the superstructure is almost as indispensable as in the tunnel work. It is not necessary to go much into detail concerning these bridges. According to the daily press, the work of construction at this writing will have actually begun upon the bridge to cross the Detroit River, connecting Detroit with Windsor, Ontario. The main span will be 1,805 feet, or more than 200 feet longer than either of the East River bridges. There will be eight suspension cables, with three decks and accommodation for traffic of every type.

The bridge to cross the Delaware from Philadelphia to Camden, New Jersey, will be quite similar and not inferior to the above in general dimensions. The bridge to cross the Hudson, however, from 57th street, Manhattan to Weehawken, New Jersey, is distinctly a different proposition and requires a strenuous mental effort for its acceptance. It is necessary for us to remind ourselves that the stresses, strength of materials and other particulars concerning bridges of this type are computable with absolute accuracy and reliability, and that it has been designed and is vouched for by Gustave Lindenthal, builder of Hell Gate Bridge. Its estimated cost is $100,000,000. The central span will be 3,240 feet, or more than twice that of Brooklyn Bridge; the suspension towers will be taller than the Woolworth Building and the anchorage piers 500 feet high and utilized as office buildings.

Here might well be the end of our story, and our title at the beginning which asserts the onerous tasks immediately depending upon the activities of compressed air might be conceded as sufficiently justified without our going still farther and mentioning the great dam building projects for power development, for irrigation, for equalization of flow and the prevention of floods, but the bridges cannot be quite so summarily dismissed. One thing leads to another as we flippantly say, when in fact every one thing leads to two or three, or often a whole new series of others. These bridges may be the opening of a bridge era, and the great Hudson River Bridge inevitably suggests still another. The uniquely magnificent residential and commercial possibilities, indeed the certainties of Staten Island's future imperatively demand a bridge across the Narrows, and who shall say that it is not now to be seriously considered and later to be certainly realized?—*R.*

WHO WOULDN'T BE AN ENGINEER?—IF HE COULD

HON. PATRICK NEFF, Governor of the State of Texas, is surely an expert in the exercise of one of the most essential of gubernatorial functions. He can produce a notable and pertinent address when the occasion for it occurs. The following, which is well worth passing along, is from his address of welcome to the Civil Engineers, Houston, April 27, 1921.

The engineer is the wonder worker of the world. What others dream, he accomplishes. What others visualize, he brings to fruition. What others imagine, he makes real. What others put into words, he works into deeds. What wild forces of nature others only admire, he tames to do man's bidding. He is the wizard of workers, and subdues the elements of earth and sea and sky.

From the building of the pyramids to the digging of the Panama Canal there has been amid the achievements of peace no obstacle too difficult for him to surmount. From changing an ancient river channel that turned, in a night, the tide of battle, to the construction of the breastworks that immortalized the fields of France, there has been amid the victories or martial conflict no problem that involved the the life or death of a nation that he has not solved.

He is a man of vast and varied intellectual accomplishments in the field of human service. He harnesses the forces of the flowing streams and thus distributes through electric currents, light and heat and power. He drains the swamps, destroys the abiding places of disease, lays out cities, constructs irrigation systems and makes the desert blossom as the rose. He tunnels the mountains and bridges the streams, as he builds railroads, highways and waterways. He lays the pulsing cables and stretches the reverberating wires under the deep sea and through the viewless air, and makes neighbors of all the sons of men, and turns the busy world into a whispering gallery. He plans and builds and digs and delves and dives and toils, and the inhabited earth is resonant with the music of his labors.

FRANCE DEVELOPING A NEW HYDRO-ELECTRIC PROJECT

THE HARNESSING of the River Rhone, long talked of, has been brought an important step nearer by the definite adoption of the project by the French Senate. Steps are to be taken to form a company to carry out the work, which is estimated to cost about 60 million francs, and to occupy several years. The City of Paris and the Paris-Lyons-Mediterranean Railroad Company will be the first shareholders.

Along the banks of the River Rhone from the Swiss frontier to Avignon there will be eighteen power stations, the largest that at Genissart, near Bellegrade, where an average of 250,000 h.p. will be developed out of a total of 1,100,000, which it is calculated will be available ultimately from the Rhone.

The P-L-M. Railroad Company intends to electrify the whole of its sector included in the quadrilateral Bellegrade-Lyon-Marseilles-Vintimille. The company plans to collect current along the river and conduct it along the railroad in the same manner as with all electric railways and no difficulties are foreseen.

The Paris scheme, on the other hand, does present some difficulties. It will be, in fact, the first time that a quarter of a million horsepower will have been transported a distance of 450 kilometres.

It is at Genissart that the current for the City of Paris will be produced. Two great feeders or transport lines will start thence, one passing through Dijon, the other through Nevers, and they will meet at the capital. Each feeder, run at a great height and supported by pylons, will consist of six cables, along which current will run at the formidable pressure of 150,000 volts.

Monsieur LE TROCQUER told the Paris correspondent of COMPRESSED AIR MAGAZINE that he regarded this as the most important piece of economic work undertaken by the French in the 20th century.

AIDING EMPLOYERS TO FIND COMPETENT MEN

RAPID FLUCTUATIONS in the demand and consumption of labor and materials always throw the adjustments of industry out of gear. Then occurs an unmerited hardship on the trained technical men who are dropped from their positions because of the total or partial shutting down of operations. Then they spend maybe months before they are able to place themselves elsewhere. Also the employer suffers because after having had in his employ for a length of time a competent technical executive he is forced to drop him from the payroll on account of the necessity of reducing expenses and he thereby loses a valuable asset.

Standardization of production has been recommended by our present secretary of commerce, MR. HOOVER, as a remedy and assuredly this is a much to be desired goal for the relief of everyone.

The wide and varied field of engineering activity has created the need of some great clearing house of engineering services from which engineers of any specific qualifications may be obtained.

In recognition of this want, the Federated American Engineering Societies, representing a combined membership of about 50,000, including the best and most representative professional engineers in the United States, has established at 29 West 39th Street, New York, an employment bureau for engineers of every variety of training and experience.

Applicants must be members, and submit a complete educational and professional record which is carefully classified, so that as the special requirements of any position are received, the records of men of suitable qualifications are submitted for consideration. The relatively large number of men with whom the bureau is in touch, the comprehensive classification of records, and the fact that the services of the Bureau are free to employer and member alike, render possible the selection of the right man for the service required. Negotiations may be confidential if desired.

The high standards required for membership in any of the member societies insure the quality of men available, and the bureau will welcome inquiries from those seeking to build up or expand their engineering organizations in preparation for the increased activity now manifest.

THE AIR BRAKE FOR THE AUTO

AMONG THE most notable phenomena of the times is the rapidity with which the automotive vehicle has come into almost universal employment, both for the entire range of industrial demand and for every requirement of personal pleasure or convenience. Not only has it so completely usurped the functions of the horse, but it has also developed the habit of employing it to such an extent that, measured by any of the standards, mileage, tonnage, time, the entire normal work of all the horses that were ever at work at once is already far exceeded every day.

We were so accustomed to, and, in a way, so satisfied with the horse that the automobile can hardly be said to have "filled a long felt want," as the glib phrase goes. It came, rather creating the wants which it was to fill so completely, entirely adapting itself to satisfy them as they developed. It has been its own pacemaker, and has had a strenuous task to keep up with itself in the satisfying of the demands which itself has successively created. It is probably true that from the beginning there have never been so many persons ready to suggest possible and desirable improvements as at present.

As our title above suggests, we have in mind one of those possible improvements still conspicuously absent. It was never necessary to suggest the need of a brake for the control of the machine, and from the first, brakes of some sort have been provided. With the full knowledge of what the air brake has done for the railroads it was impossible not to think of the same device for the auto. The wonder is that it has not already been installed, and it is here, if anywhere, that the auto has failed to keep up with itself in its rapid career of improvement. There can be no question as to the ultimate adaptation to and adoption of the air brake for this responsible service. The only question can be as to when or how soon it will be accomplished. There are mechanical difficulties to be overcome such as inventors delight to tackle, but the problem is not greater than thousands of others which have been successfully solved, and we can only wait with confident expectation and perhaps a growing impatience for what is sure to come.

The air brake on the auto, when it comes—and we are hearing some whisperings that it is already on the way—will be not merely another brake in approximately equal competition with the rest, but necessarily a better brake than those which it supersedes, so that in the not remote future we may expect it to reign unchallenged. For one thing, and that not a little thing, it will be applied to all

the wheels and all with equal force as required. This braking of all the wheels will greatly reduce the danger of skidding or steering and add to the safety of the machine. It would be premature to attempt to discuss all the possibilities and promised advantages, but the temporary delay cannot weaken our confidence. *R.*

MANUFACTURING REVIVAL HAS BEGUN

RENEWED COURAGE, determination to make a go of things, confidence that envisions better business after the depression shall have passed—all the mental bucking up that is generally described by the phrase "improving sentiment"—these things are essential to a real revival of manufacturing activity. But quite often when we are talking of better sentiment, if we would but look for it, we might find tangible evidence of better business. Here are some statistical data, which a writer in *Forbes Magazine* (N. Y.) says reveal "pretty good gains for a period wherein so many people imagined there was no real improvement in trade."

For the first four months of this year there has been an increase of 31 per cent. in our imports of crude materials for use in manufacturing. This is measured in value rather than quantity; so that, as prices have been going rapidly downward, the gain in quantity is probably around 40 per cent. In brief, carloadings show that manufacturers have been shipping to dealers their surplus stocks of finished goods and buying more coal with which to produce more goods; and imports of crude materials make it plain that manufacturers have been enlarging their purchases of supplies.

Nor is this all of the tangible, unmistakable evidence of a general betterment in the manufacturing industry. The Labor Department at Washington each month obtains returns from nearly 800 manufacturing plants scattered throughout the United States, showing the numbers of persons employed and the amount of the payroll. These returns disclose the facts that manufacturing was at its minimum the beginning of the year, and that it has been moderately improving ever since.

We are warranted in concluding that the manufacturing revival is a fact, and not merely a hope or a dream. It is slow, and it is neither uniform nor universal. Some industries have not yet joined the march toward better times, but in due course they will. If one's own business is still on the downward trend, the best policy should be to take courage and begin calculating when the inevitable revival will reach it, and how best to take advantage of the revival. Faith and hope are not necessary, because all that is required to be convinced of the slow but steady recovery is open-eyed observation.

Producers and traders in goods for home consumption may expect almost immediate further improvement, and business in expansion materials promises faithfully to revive as soon as consumption grows enough to pretty full utilize our existing capacity.

AIR PRESSURE IN TANK TO FORCE WATER

The following query has been brought to our attention with a suggestion that we supply the information sought.

"We have at our mine a water tank that we want to put under pressure, for the purpose of forcing water out of the tank with a service pipe for use as desired. The tank is 36 in. in diameter and 10 ft. long. Assuming it is two-thirds full of water and put under a pressure of 150 lb. per sq. in., I want to ask: what will be the pressure in the tank when the water has been forced out until it is only one-third full? Also, what will be the final pressure in the tank when all the water has been forced out and the tank is empty? I want to ask, in what proportion does the pressure fall as the water is forced out of the tank?"

We may assume that in this case the water is drawn off slowly or intermittently, so that the air may recover its drop of temperature which would accompany its expansion, and that at the end of the operation its temperature would be the same as at the beginning, or, as we say, its expansion would be isothermal. In isothermal expansion (or compression) of air its absolute pressure is inversely as its volume. When the two-thirds of a tankful of water is drawn down to one-third of a tankful, the volume of air is expanded from one-third of a tankful to two-thirds of a tankful. Its volume thus being doubled its absolute pressure will be reduced one-half, or $(150+14.7)\div 2=82.35$ lb. absolute pressure, or $82.35-14.7=67.65$ lb. gage pressure. So, when the water is all drawn off and the air has expanded to three times its original volume its absolute pressure is reduced to one-third, or $(150+14.7)\div 3=54.9$ lb. absolute pressure, or $54.9-14.7=40.2$ lb. gage pressure.

AUTOMOBILE WASTE OF GAS

Dr. A. C. Fieldner, supervising chemist of the U. S. Bureau of Mines, Experiment Station at Pittsburgh, Pa., has found as a result of extensive investigations that nearly one-third of the gasoline used in automobiles is wasted. The experiments were conducted to ascertain the pollution of the atmosphere of the vehicular tunnels now under construction in New York City, by motor vehicles. The experiments were made under the same conditions as apply to actual traffic. The chief cause of the waste is a too rich gasoline mixture. An improved form of carbureter should be devised, which should be practically automatic in operation. On the basis of 34 cents per gallon, American automobilists are using about $115,000,000 worth of gasoline a year, of which, according to Doctor Fieldner, about $34,000,000 could be saved by improved methods, largely in better construction and operation of carbureters.

Mexican Eagle has bought Oilfields of Mexico, the capital of which is $8,500,000. The oil lands involved in the transaction are located in Vera Cruz and Pueblo and comprise a large area under ownership or concessions.

ALL WORKERS APPRECIATED

THE AUTHOR of the following is not identified except that he is one of the officials of the Firth-Stirling Steel Company, Pittsburgh. The lines are first brought to our notice as occurring in a letter in *Iron Age*, Aug. 4:

The Practical Man or the Technical Man—
Which has the right to boast
That he is the one that brings success,
That Industry needs him most?

The driving wheel or the steering wheel,
Ignition or carbureter,
Which is the most essential part?
Which would you call the better?

Airman, gunner or engineer—
Which do you think did more?
General Staff or infantryman—
Who was it "won the war"?

If by a chance you had the power
To fashion yourself again,
Would you omit your arms and legs
And put in an extra brain?

Then let us forget this foolish talk
Of "whom do we most require";
Why—the Technical Man and the Clerical Man
And the Practical "Man at the Fire"!

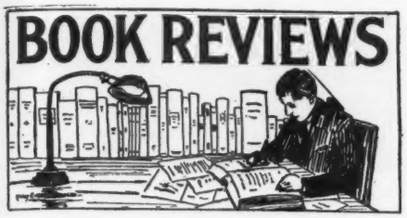
VEHICULAR TUNNEL VENTILATION

THE TUNNELS which are to be carried through the South Hills at Pittsburgh will be the largest highway tunnels yet built, with a length of 5,715 feet. The ventilation arrangements will be of special interest, as this is the first long tunnel in which automobile exhaust has had to be dealt with. There are two tubes, each providing for two lines of traffic with space for street cars, the traffic in a tube to be all in one direction. The maximum estimated traffic is 1,690 vehicles per hour in each direction, mostly passenger vehicles. Ventilation plans are being based on special tests, conducted by the U. S. Bureau of Mines, of automobiles for carbon monoxide emission, and of the susceptibility of human beings to that gas. Air will be blown in at one end by lateral nozzles in the direction of traffic. A pumping plant for each tube distributing normally 200,000 cubic feet over the 468 square feet of cross section will give an air current velocity of six miles an hour.

According to the bulletin of the Republic of China government Bureau of Economic Information, Dr. J. A. L. Waddell, an American, has arrived in China to become the American member of the commission of four to examine designs for the construction of a new bridge across the Yellow River.

Quarries producing sandstone and bluestone throughout the country employed 4,466 men in 1920, according to reports from the operating companies received by the United States Bureau of Mines.

BOOK REVIEWS



UNITED STATES STEEL, a Corporation With a Soul, by Arundel Cotter. A presentation of facts about the United States Steel Corporation gathered from the records of the company. It is the story of the steel industry giving in detail the development of our greatest corporation. Price, $3; 312 pp; fully illustrated; with appendix.

THIS VOLUME contains so many interesting and descriptive chapters on the evolution of steel making that it is but barely possible in these columns to convey to the reader only a very partial and incomplete idea of the contents.

The formation of the great United States Steel Corporation marked an era in corporate finance. In fact, it is epochal and has never since been equaled. The story reads like a romance and anyone with a degree of imagination must become intoxicated with the financial details of the launching of this great industrial enterprise. It was the most stupendous industrial undertaking the financial world had known.

The overtures and subtle moves of Carnegie and Morgan in the battle of wits between these wizards of finance and the final intervention of "Charlie Schwab" between the "Iron Master" and the financier resulting in the formation of the corporation is told with an intimate wealth of detail that will reveal to the reader many interesting incidents and anecdotes that will prove of the highest interest.

The great success of the organization is attributed to Judge Elbert H. Gary, whose wisdom, foresight and courage have marked the progress of U. S. Steel throughout its history and were displayed in a marked degree in the dark days of the panic of 1907 and again in 1919 when the great steel strike threatened.

Morgan, Frick and Perkins, all these and others, we are told, have helped with their counsel in bringing the corporation to the preëminent place it holds today, but one man has stood out among all the rest—Elbert H. Gary.

All this is historical it is true, but the reader will find lots of interesting sidelights from which to draw conclusions in these preceding chapters.

Further on, the volume deals with the internal workings of the organization and its outside relations with the public.

The internal workings of the corporation and the methods of securing coöperation among its many different plants are revealed with an amount of facts and description that show an actual working knowledge on the part of the author.

In analyzing the methods of managements and the means taken to secure the wholehearted support of executives and men an insight is given into the reasons for increased production, elimination of waste and the lowering of costs.

Indeed, it is a convincing description of why this new company foredoomed to failure which, because of its very size, prophets claimed would render it unwieldy, has succeeded and today is so strongly intrenched financially that the possibility of borrowing for plant additions ever becoming necessary has been put into the future and possibly eliminated forever.

We are given in later chapters an account of The Early History and Growth, the Tennessee Purchase, Developing of the World's Markets, a brief description of the Men Who Made United States Steel, and several other interesting phases of the growth of this remarkable institution.

In the last mentioned chapter there are related many interesting stories about the men who have been responsible for directing the policies and destinies of the company.

An important work is being performed by the company which should not be passed over lightly, and in which it was one of the earliest pioneers, and that is the humanizing of industry.

In opening his chapter on this subject the author says: "Of all the problems with which industry is confronted none is more important or more difficult of solution than that of establishing proper and harmonious relations between the man who works with his hands and the individual or corporation who pays him his wage."

About the year 1906, the Steel Corporation initiated a campaign of safety, sanitation and welfare, and statistics demonstrate its enormous success in preventing accidents and deaths.

To sum up the contents of this most interesting volume it presents the human interest side of the great corporation, its relations with its workers, its efforts to better their condition and the keen interest shown in their welfare. Here is told the animated spirit of the vast enterprise, the implements with which it works, its work in the war, its attempted dissolution by the United States Government, the personalities of the men who had most to do with its history—Gary, Morgan, Schwab, Perkins, Farrell—all these and more are related in a manner to interest the average reader as well as the student of economics.

AMERICAN BUSINESS METHODS, for Increasing Production and Reducing Costs in Factory, Store and Office. By FLOYD W. PARSONS, E. M., Member American Institute Mining and Metallurgical Engineers; Mining and Metallurgical Society of America; Academy of Political Science; Founder and Former Editor, *Coal Age*, and Author *Everybody's Business* in *The Saturday Evening Post*. Indexed, 373 pp. New York and London; G. P. Putnam's Sons.

MANUFACTURING or industrial executives and their chief assistants who are not familiar with that very excellent work from the pen of that busy investigator, Mr. Floyd W. Parsons, on all the important problems that underlie modern commercial and industrial practice will find it full of pertinent suggestions, helpful methods adequately expounded and sage advice.

The data contained in this volume have been gathered from hundreds of leaders in dozens of industries. Much of the information has resulted from careful research and personal interviews and has formed the foundation of articles published in the *Saturday Evening Post's* department "Everybody's Business." In fact the creation of the volume has been largely the result of the requests of many of the *Post* readers for the preservation in book form of the facts recorded in the numerous articles that have appeared in the past.

The purpose of the book is to supply the reader with practical knowledge of ways and means to increase production in any and all lines of business. In a material sense, the author says in his preface that production is the true measure of success of a corporation or an individual. Generally speaking the fundamental principles of business are quite similar whether a man manufactures locomotives or sells lead pencils.

The various subjects treated by Mr. Parsons include quite a wide range as in the different chapters he treats on: "Industrial Relations," "Health and Industry," "Light and Ventilation," "Labor Saving Machinery," "Advertising and Selling," "Business Methods and Ideas," "Foreign Trade Problems," and "Application of Science to Industry." Perhaps none of our present generation of authors could prove so facile in handling all the phases of a highly complex modern business and in doing this Mr. Parsons has rendered the business world a service. It is probably true that the book as a whole represents more research and more hours of labor than has ever before been devoted to any work of a kindred nature.

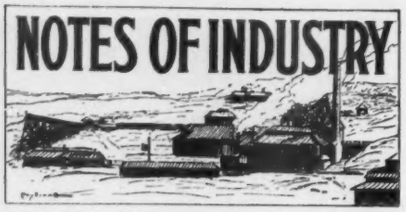
It is hard to select from the many subjects contained in the volume any one more important or valuable than the others but the chapter dealing with labor saving devices will prove quite interesting to the mechanically inclined reader as regards the actual examples of increased production and the history of the introduction of different devices such as typewriting, nail-making, milling, grain threshing and a host of others.

These are instances where necessity being a stimulus to invention proved the truth of the statement that on our engineers and inventors depend in large measure the solution of the labor problem.

MINERAL RESOURCES OF ALASKA, a report of progress of investigations in 1919 by ALFRED H. BROOKS and others. Bulletin 714, United States Geological Survey. Washington, Government Printing Office.

THIS VOLUME is the sixteenth of a series of annual bulletins treating of the mining industry of Alaska and summarizing the results achieved during the year. It contains an account of the mineral production and is intended as a reference work for the period covered. The decline in price of copper since 1916 greatly reduced Alaska's output and the world-wide depression of the gold industry also had greatly affected Alaska. In 1919, the total mineral output of the Territory was $19,621,000 as compared with $28,254,000 in 1918 and was the lowest annual value since 1914. This treatise will prove of unquestionable value to every mining man as a reference book containing as it does numerous maps and tables of mineral outputs classified according to districts.

E. P. M.



In California there are about 2,467 miles of main trunk pipe line and 50,000 miles throughout the United States. The oil pipe-lined from Texas to the refineries at South Chicago travels 2,800 miles. Were the expense incurred in the operation of these lines to fall upon the small producer, the cost would be prohibitive. So, under the present working order, the marketing concerns take over the transportation problem. The costs involved are taken into consideration in the price offered the producer for his oil.

A recent report showed that the Ford company had orders on its books for 140,000 cars with production at the rate of fully 100,000 cars per month. Dodge Bros. were understood to be booked for more than 30,000 cars, and the Buick Co., producing at a high rate, is behind on its orders.

Cuba's foreign commerce during 1919-1920 exceeded $1,290,000,000, an increase of 64 per cent. over the previous year.

During the ten years from 1909 to 1919, the production of condensed milk in this country increased 410 per cent. In 1919, 2,030,958,000 pounds of condensed milk, with an approximate market value of $200,000,000 were put up by the 240 plants engaged in this business.

Diamonds within the reach of the most modest purse, fine large diamonds at that, is the promise of M. E. de Boismenu, a French savant. Of course they are to be "synthetic" stones, but the scientist declares they are just like the best product of the South African diamond mines, and not even an expert can tell the difference because there is no difference.

Up to date the French scientist has produced diamonds one-ninth of an inch in diameter. He did it by burning carbide of calcium in an electric furnace. The carbide melts at 5,000 degrees Fahrenheit, and the electrolytic action of a direct current of high intensity separates the elements of the melted mass. The calcium, he says, goes to the negative pole, where it burns; the carbon thus set free crystallizes in the form of a diamond in the slag in the bottom of the furnace. At first only small microscopic crystals were found after the operation, and it has taken some years for the scientist to bring his experiments to the present stage of development.

Announced officially though explained as provisional, subject to exact verification later, the population of continental France for 1921 (census of March 6) is 36,084,206, as compared with 38,468,753 in 1911, thus showing a loss of 2,384,547. Not included therein are the figures for Alsace, Lorraine and Algeria, which will be published later. The population of the Department of the Seine, which comprises Paris and environs, is 4,411,446. Therein are included 233,849 foreigners. One of the results of the decrease in total population will be a decrease in the number of Deputies from 626 to 530.

Through a deal just concluded the California Car Company has taken over a portion of the Enterprise Foundry Company of San Francisco, and will use it as the first unit of a plant for the manufacture of gasoline-propelled street cars, it is announced through the Chamber of Commerce.

The second unit of the plant will be built upon twelve acres adjacent to the foundry, it is planned. The company is a $500,000 corporation and plans to build 100 cars the first year.

In 1917, American glass manufacturers produced 75,000,000 square feet of polished plate glass.

The New Era Iron & Steel Corporation will open its smelter in Sedro Woolley some time in October. The past few months have been used in experimenting with making iron from black sand. Some of the finest pig iron made in the United States, it is declared was produced in recent trials. It is planned to use ore from nearby hills mixed with the black sand.

The largest stock of gasoline (essence) ever known in the United States was that of April 30, 1921, the total being 755,000,000 gallons (2,857,675,000 litres), showing a net increase of 42,000,000 gallons over the figures for March.

A PNEUMATIC HOISTING BRAKE

The new Jordan pneumatic brake as applied to hoists and mine winding gear comprises a design of key valve for releasing the brake at the moment the cage descends, according to *Leitschrift des Vereines Deutscher Ingenieure*. There is also a retarding governor inserted between the key valve and the buffer cylinder, and which governs the braking effort, through a weight which moves in the direction of travel, and regulates the air pressure in the buffer cylinder so that the cage is held with a uniform retardation of ten m. per second on its downward and upward travel. A separate speed regulating device is also fitted to the cage, for the purpose of releasing the brake in cases where the cage overruns, and so allowing the end cut-out to operate in time. Some tests are described with the new brake which were carried out at the Charlottenburg Technical College, and a table showing the comparative figures for winding operations, using Koepe winding gear with and without the Jordan brake. The writer also discusses the possibility of applying the new method to mine shaft winding gears.

Mr. Vance McCarty, prominent in the leather belting industry, has resigned as vice president of the Edward R. Ladew Co., and has been elected vice president of the Chicago Belting Company, with headquarters in New York.

* * *

Mr. Bradley Stoughton, after eight years' service as Secretary of the American Institute of Mining and Metallurgy, has resigned and will resume his practice as consulting engineer.

* * *

Mr. H. C. Dickinson, who has been for some years chief of the Bureau of Standards, has been granted a year's absence to become director of research of the Society of Automotive Engineers.

* * *

Mr. E. A. Richardson has accepted a position as chief chemist for the Libbey Glass Co. Mr. Richardson has been connected with the National Lamp Works of the General Electric Co., Cleveland, Ohio.

* * *

Mr. Robert B. Woodworth, has resigned from the Carnegie Steel Co. after having been affiliated with that Company for 24 years in different capacities from draftsman to advertising manager and sales statistician, which position he held at the time of his resignation.

* * *

Mr. F. J. Janney, who has been connected with the Utah Copper Co. for the past sixteen years as superintendent of mills, has resigned to take a position in New York.

* * *

The Standard Oil Co. of Los Angeles has engaged the services of Mr. J. B. O'Sullivan of Nevada. Mr. O'Sullivan has served for nearly eight years as U. S. surveyor general for Nevada.

* * *

Frederick Upham Adams, author and inventor, died suddenly of heart disease at his home in Larchmont, N. Y. Mr. Adams was born in Boston Dec. 10, 1859, studied mechanical engineering and practiced that profession for several years. From 1894 to 1897 he was smoke inspector in Chicago and in 1900 he constructed an experimental train for the Baltimore & Ohio Railroad that broke speed records.

* * *

Dr. F. G. Cottrell, head of the chemical activities of the National Research Council, is expected to return from France on October 11, where he has spent some time studying different phases of the chemical industry.

* * *

Dr. Reuben S. Tour, Government chemical expert, has been appointed professor of chemical engineering at the University of Cincinnati, Cincinnati, Ohio. Dr. Tour will continue as a consulting expert for the Government.

VETERAN MINER RECALLS PRACTISES IN EARLY DAYS

WE OF TO-DAY are very apt to accept most of the modern labor saving methods and machines as a matter of course, without much thought to the pioneering which preceded their adoption. It is therefore interesting to hear from one who has followed the mining game for a full 50 years and who has ever been in the lead in accepting and introducing improved methods. It is a pleasure to reprint this letter from our good friend, Mr. Joseph Matchette, a veteran of the Civil War but still actively interested in mining and compressed air applications.

To the Editor:—

WHILE on a visit to the Cornwall Ore Banks last fall I had a wonderful opportunity to observe the many changes made in these mines since my first visit in 1882. At that time I had gone to sell them blasting powder and introduce to them the use of steam drills, batteries, caps, etc.

On that first trip I was amazed at the sight of those wonderful hills of magnetic ore. Common black powder was loaded in holes drilled by four men with a long steel-pointed drill having wooden handles, arranged at a convenient distance for the men to churn the drill up and down.

My previous experience with powder, dynamite and steam drills in stone quarries caused me to believe that similiar methods could be used in handling soft iron ore. I explained this all to the manager, Mr. Boyd. He at once became interested, asking many questions relating to blasting, steam drills, dynamite, electric batteries, etc. However, he was skeptical about the drills working in their soft ores.

On that first trip I sold him 300 pounds Judson and Giant Powder which I later on hauled to him with a horse and wagon as the railroads would not carry dynamite. He also agreed to buy a steam drill if I would supply an operator. He later on ordered a drill and I got

Mr. Joseph Matchette.

my nephew to run the machine and train others to operate it.

Naturally some difficulty was experienced in cleaning the holes of the iron dust but that was overcome by inserting a small pipe into the hole alongside the steel drill and attaching it with hose to the steam pipe.

Mr. Boyd later on found the necessity of using compressed air in his workings on Big Hill, Middle Hill and Grassy Hill. The compressor first purchased was a straight line machine which soon proved too small for the work and was replaced by a Corliss machine, which is possibly still doing duty.

The big ore banks have undergone a remarkable change since those days; the Big Hill is about all stripped; the Middle Hill which was once 30 or 40 feet high above the creek level is now nearly 100 feet below it. The same may be said of Grassy Hill. The ore is now drilled with air, blasted with high explosives and loaded with steam shovels into cars for shipment to the furnaces, which is a remarkable development as iron ore was once mined here to make cannons for Washington's Continental Army.

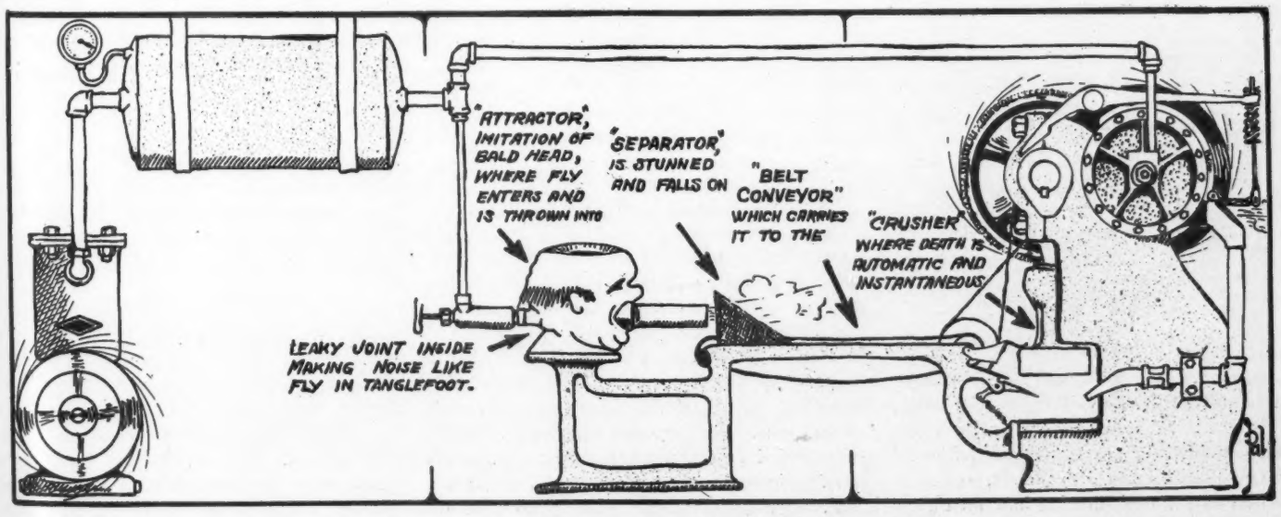
Respectfully,

JOSEPH MATCHETTE.

PROBLEMATICAL COMPRESSED AIR SCHEMES

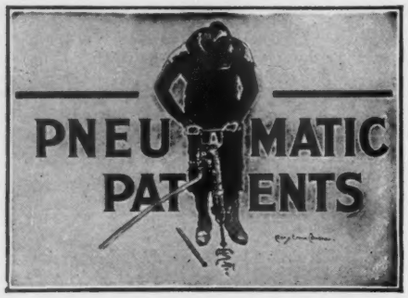
A Rumanian engineer, Mr. A. Beldimano (*Times Engineering Supplement*), proposes to drill deep artesian wells at the highest point of an anticline where a water stratum is to be found beneath a fairly thick clay stratum, and to drive his energy in the form of compressed air into the well, when the air will replace the water in the pores of the sand of the water stratum. In this way he would obtain a cheap and absolutely air-tight container of any desired capacity. The compressed air in the reservoir could be conveyed by pipe lines to any desired point and used in motors for the production of mechanical power, or an electrical power station might be established at or near the reservoir and the power transmitted electrically. The second part of his scheme contemplates the production of large quantities of compressed air, at a pressure of say ten atmospheres, from the energy of the waves of the sea. For this purpose he would anchor pontoons in the sea at a suitable distance from the shore, and would install in them air compressors with a simple mechanism operated by the varying tension on the mooring line as the pontoons are moved up and down by the waves. The compressed air thus obtained would be conveyed by pipe lines to the artesian containers on land.

According to a recent despatch from Berlin 419,000 metric tons of potash were sold in Germany between January 1 and July 31, 1921.



KILLING FLIES WITH COMPRESSED AIR

The above cartoon by C. H. Morrow was inspired by an article in the July issue of COMPRESSED AIR MAGAZINE *describing how various pests are exterminated in grain elevators and mills by blowing compressed air at 35 lbs. pressure through the chutes.*—THE EDITORS.



JUNE 28

1,382,640-1. SPRAY-GUN. Walter A. Heinrich, St. Louis, Mo.
1,382,722. POWER - DRIVEN TIRE - PUMP. John G. Graham, Tomah, Wis.
1,382,769. FLUID-PRESSURE GENERATOR WITH AUTOMATIC AIR-COMPRESSOR. George Jones Ferguson, St. Louis, Mo.
1,382,775-6-7-8-9. STONE - DRILLING ENGINE. George H. Gilman, Claremont, N. H.
1,382,821. POWER-HAMMER. Charles B. Coates, Chicago, Ill.
1,382,831. PNEUMATIC CUSHION. Frank C. Hilker, Fort Wayne, Ind.
1,382,862. AIR-NOZZLE FOR LOCOMOTIVE-SANDERS. John W. Simpson, Santa Barbara, Calif.
1,382,900. EMERGENCY - AIR - BRAKE ATTACHMENT. Joseph B. Fountain and John B. Parker, Lakeland, Fla.
1,383,067. PNEUMATIC HEEL. Emil Borman, Chicago, Ill.
1,383,210. FLUE-BLOWER. Robert Edward Jackson and Edwin Milton Jenkins, Princeton, W. Va.
1,383,258. CONSTANT - VOLUME REGULATOR FOR TURBO-COMPRESSORS. Paul Hoffman, Easton, Pa.

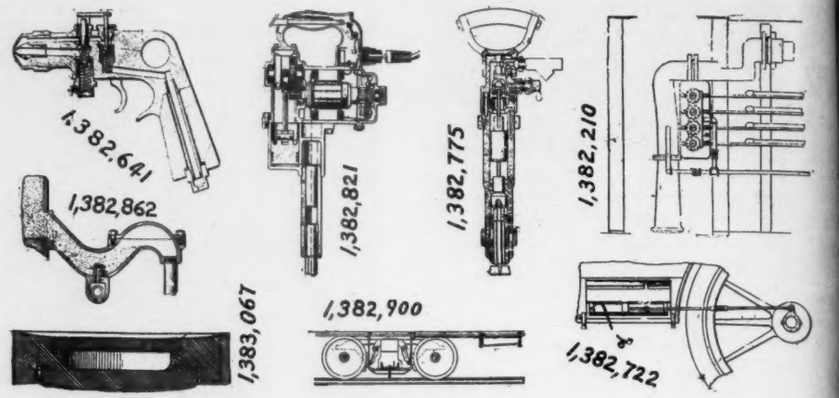
JULY 5

1,383,276. BLOWTORCH. James A. Anderson, Chickasha, Okla.
1,383,371. APPARATUS FOR BURNING PULVERIZED FUEL IN LOCOMOTIVES. Henry R. Barnhurst, deceased, Catasauqua, Pa.
1,383,441. AIR - SEPARATOR. Thomas J. Sturtevant, Wellesley, Mass.
1,383,455. CLEANING APPARATUS. William W. Farnsworth, Littleton, Colo.
1,383,461. WIND-MOTOR. Franklin B. Giesler, Milwaukee, Wis.
1,383,657. AIR-COMPRESSOR. Juan Noguera, Buenos Aires, Argentina.
1,383,860. COMPRESSOR. Adolf Roszkowski, New York, N. Y.
1,383,866. LIQUID-GAGE. James Shephard, Detroit, Mich.
1,383,915. RIVETING MACHINERY. Charles Remi Engel, Yoman, Wash.
1,383,967. BLOWER FOR THRESHING-MACHINES AND THE LIKE. Wilfrid Ouellette, St. Scholastique, Quebec, Canada.
1,383,984. ADJUSTABLE AIR-SEPARATOR. William G. Clark, Chicago, Ill.

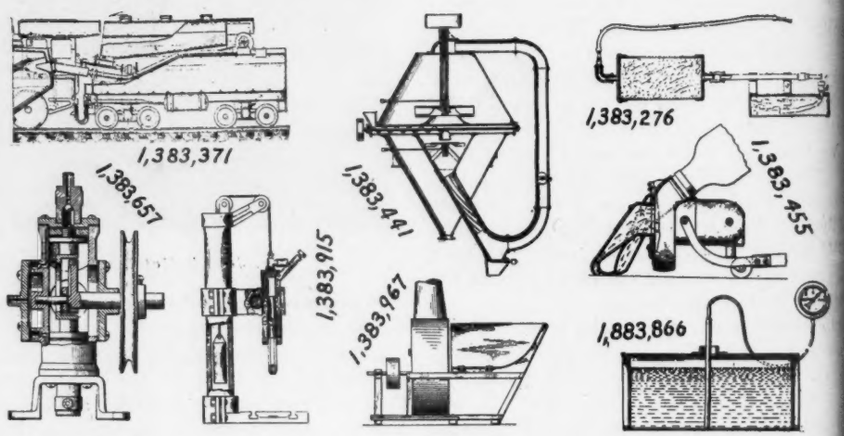
JULY 12

1,384,216. ROCK-DRILL. William A. Smith, Phillipsburg, N. J.
1,384,224. OXYACETYLENE - BLOWPIPE. Isaiah Allison, Downers Grove, and William J. Leighty, Chicago, Ill.
1,384,266. PULSATOR FOR MILKING-MACHINES. Robert Maes, Calgary, Alberta, Canada.
1,384,276. ROTARY PUMP OR COMPRESSOR. Gustav B. Petsche, Yonkers, N. Y.
1,384,383. MIXING AND AERATING MACHINE. William Vanson Dawkings, Whitstable, England.
1,384,641. BLOWING DEVICE FOR PERCUSSIVE TOOLS. William A. Smith, Easton, Pa.
1,384,689. GRAIN DRIER AND COOLER. Monroe Davis, Enid, Okla.
1,384,702. AIR-MOISTENER. Joseph Francis Maloney, Cleveland, Ohio.
1,384,724. VACUUM-REGULATOR MACHINE. Louis Le Bras, New York, N. Y.

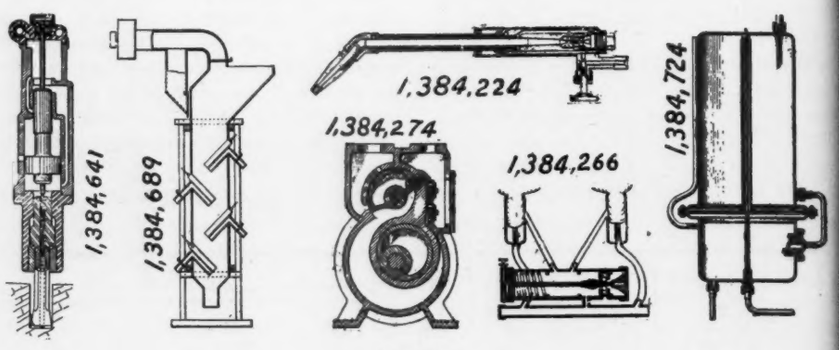
The Bulletin of the Department of Labor and Industry, Commonwealth of Pennsylvania, January, 1921, by Clifford B. Connelley, Commissioner, has been recently received. The bulletin contains a report of the activities of Bureau of Rehabilitation to Jan. 1, 1921. It is profusely illustrated showing how men after having suffered major injuries are now performing useful work.



JUNE 28



JULY 5



JULY 12

AN UNUSUAL FUEL STORY

According to reports received by the United States Bureau of Mines from the various state mine inspectors, 127 men were killed during March, 1921, in and about the coal mines of the United States, as compared with 181 killed in March, 1920. Thus the 1921 figures show a decrease of 54 fatalities, or about 30 per cent, from the record of the corresponding month of last year. For the same months, the output of coal fell from 54,689,000 tons to 37,342,000 tons, a decrease of 17,347,000 tons, or 32 per cent, attributable almost entirely to lack of demand. Based upon the production for March of last year, 3.31 lives were lost for each million tons of coal produced; March, 1921, the corresponding fatality r was 3.40 per million tons mined.

The Du Pont Company has developed perfected a formula for the manufacture straight dynamite which results in that plosive being proof against freezing even zero temperatures. As a consequence of development, the company has determined discontinue the manufacture of its for straight dynamite and hereafter all this k of explosive will be made by the new l freezing method.